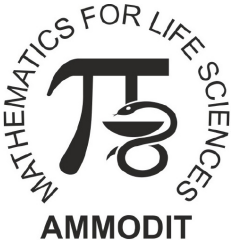

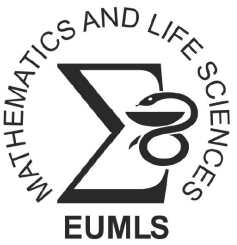

AMMODIT and final EUMLS Workshop

Mathematics for Life Sciences

Hasenwinkel, March 07 – 11, 2016

Information on the projects:

The goal of the EUMLS project is to contribute to overcoming the historical communication and cross-disciplinary barriers that exist between the biosciences and mathematics through a comprehensive 48 month research staff exchange programme between five Ukrainian mathematical institutes and three partners in Germany, Italy, and Norway already active in different aspects of computational life sciences.

April 2012 — March 2016
Marie Curie Actions — International Research Staff Exchange Scheme
FP7-People-2011-IRSES Project number 295164

The goal of the AMMODIT project is joint research in six research tasks concerning the study of mathematical methods for Magnetic Particle Imaging; entropy-like measures and quantification of system complexity; coarse-grain modelling for (bio)polymers; diagnostic tools for cardiac surgery; regularization methods for causality detection; meta-learning approach to Nocturnal Hypoglycemia prediction. This project brings together research teams from the EU (Germany, Italy, and Austria) and the Ukraine (Kyiv, Donezk) in the area of applied mathematics with emphasis on medical and life science applications.

August 2015 — August 2019
Marie Skłodowska-Curie Research and Innovation Staff Exchange
H2020-MSCA-RISE-2014 Project number 645672

Acknowledgements: The EUMLS project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 295164. The AMMODIT project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 645672.

Information on the workshop: This conference continues the series of events to be organized in the framework of the Marie Curie IRSES project "EU-Ukrainian Mathematicians for Life Sciences" (EUMLS) and the Marie Skłodowska-Curie RISE project "Approximation Methods for Molecular Modelling and Diagnosis Tools"(AMMODIT). The previous conferences were in Kyiv, September 2012, in Olenivka, September 2013, and in Rivne, September 2015.

The conference is devoted to recent research in life sciences based on applications of mathematics to biological and medical studies. It is a multidisciplinary meeting forum for researchers who develop and apply mathematical and computational tools to the study of phenomena in the broad fields of biology, ecology, medicine, bioengineering, environmental science, etc.

Organizing Committee:

Alexandra Antoniouk (Ukraine)
Oleg Chertov (Ukraine)
Yurii Kolomoitsev (Ukraine)
Hans Petter Langtangen (Norway)
Taras Melnyk (Ukraine)
Valeriya Naumova (Norway)
Igor Nesteruk (Ukraine)
Sergei Pereverzyev (Austria)
Jürgen Prestin (Germany)
Alberto Redaelli (Italy)
Nataliya Vasylyeva (Ukraine)

Dates: 07–11 March, 2016.

Location: Hasenwinkel, Germany.

V. V. BILET [1], O. A. DOVGOSHEY [1], J. PRESTIN [2]

Boundedness of Lebesgue Constants and Porosity

[1] *Institute of Mathematics of NASU, Kyiv, Ukraine*
E-mail: viktoriiabilet@gmail.com, aleksdov@gmail.com
[2] *Universität zu Lübeck, Institut für Mathematik, Lübeck, Germany*
E-mail: prestin@math.uni-luebeck.de

Let X be a compact subset of $\mathbb{R}$. We discuss some conditions under which there is an infinite matrix $\mathfrak{M} \subseteq X$ such that the Lebesgue constants $\Lambda_{n,X}(\mathfrak{M})$ are bounded for the classical Lagrange polynomial interpolation. Some sufficient conditions on X under which there is $\mathfrak{M} \subseteq X$ such that $\lim\limits_{n\to\infty} \Lambda_{n,X}(\mathfrak{M}) < \infty$ can be expressed in terms of porosity.

Recall (see, e.g., [1]) that the *right lower porosity* of X at $x_0 \in X$ is the number $\underline{p}^+(X, x_0) := \liminf\limits_{r\to 0^+} \frac{\lambda(X,x_0,r)}{r}$ where $\lambda(X, x_0, r)$ is the length of the largest open subinterval of $(x_0, x_0+r)\backslash X$ which could be the empty set. Replacing $(x_0, x_0 + r)$ in the above definition by the interval $(x_0 - r, x_0)$, we encounter the notion of the the *left lower porosity* $\underline{p}^-(X, x_0)$. The *lower porosity* of X at x_0 is the number $\underline{p}(X, x_0) := \underline{p}^{\mp}(X, x_0) \vee \underline{p}^-(X, x_0)$. The set X is *strongly lower porous* if $\underline{p}(X, x_0) = 1$ for every $x_0 \in X$. Consider now a modification of the lower porosity $\underline{p}^*(X, x_0) := \underline{p}^+(X, x_0) \wedge \underline{p}^-(X, x_0)$.

Proposition 1 *Let X be a compact subset of $\mathbb{R}$. If the inequality*

$$\underline{p}^*(X, x_0) > \frac{1}{2}$$

holds for every $x_0 \in X$, then we can find $\mathfrak{M} \subseteq X$ such that the sequence $(\Lambda_{n,X}(\mathfrak{M}))_{n\in\mathbb{N}}$ is bounded.

Proposition 2 *There is an infinite strongly lower porous compact $X \subseteq [-1, 1]$ such that for every matrix $\mathfrak{M} \subseteq [-1, 1]$ we have*

$$\limsup_{n\to\infty} \Lambda_{n,X}(\mathfrak{M}) = \infty.$$

[1] V. V. Bilet, O. A. Dovgoshey, *Real Anal. Exch.* **39**, no. 1, (2014), p. 175-206.

C. BUJ [1], M. MÜNTER [1], J. HORSTMANN [1], R. BRINKMANN [1,2]

Speckle-based off-axis holographic detection for non-contact Photoacoustic Tomography

[1] *Medical Laser Center Lübeck GmbH, Lübeck, Germany*
E-mail: buj@bmo.uni-luebeck.de
[2] *Institut of Biomedical Optics, University of Lübeck, Germany*

Photoacoustic imaging has become very popular in recent years. It is based on the photoacoustic effect, which describes the emission of thermoelastic pressure waves, generated by absorbers subsequent to short-pulsed optical excitation. The high contrast is caused by the wavelength-dependent optical absorption of chromophores inside a tissue. There are various methods to detect these pressure transients at the tissue surface. Commonly pressure measuring sensors e.g. piezoelectric transducers are used that require acoustic contact [1].

A very fast innovative holographic off-axis noncontact detection method for Photoacoustic Tomography (PAT) is introduced [2, 3]. It measures the surface displacements of the object, caused by the photoacoustic pressure waves, interferometrically in two dimensions to overcome one of the main problems of most state-of-the-art photoacoustic imaging approaches that is the requirement of acoustic contact between specimen and detector.

Based on the measured sureface displacement data a tomographic reconstruction leads to the three dimensional location of the absorbers. A reliable reconstruction proves the ability of the method.

[1] Minghua Xu and Lihong V Wang. "Photoacoustic imaging in biomedicine". In: *Review of scientific instruments* 77.4 (2006), p. 041101.

[2] C. Buj, J. Horstmann, and M. Münter. "Speckle-based holographic detection for non-contact Photoacoustic Tomography". In: *Proc. Biomed. Tech.* 59 (2014).

[3] Jens Horstmann et al. "Full-field speckle interferometry for noncontact photoacoustic tomography". In: *Physics in medicine and biology* 60.10 (2015), p. 4045.

A. CAIMI[1], G. INFANTE [1], F. STURLA [1], E. VOTTA [1],
A. REDAELLI [1]

Finite Element Simulation of a Transcatheter Aortic Valve Implantation

[1] *Department of Electronics, Information and Bioengineering, Politecnico di Milano, Milan, Italy*
E-mail: alessandro.caimi@polimi.it

Background. Transcatether Aortic Valve (TAV) implantation is a recent minimally invasive technique for valvular replacement, designed for patients who are not eligible for traditional open-chest surgery due to connected high risks [1]. Accordingly, a prosthetic device consisting in a metallic stent supporting an artificial biomorphic valve is implanted in the native aortic root via percutaneous procedure. Two TAV types are commonly used in the clinical-practice based on either balloon-expanded or self-expandable stents. The former are characterized by an expansion procedure via the inflation of a balloon, which induce a plastic deformation of the stent structs. The latter are capable of expanding themselves without plastic deformation, once extracted from the guide catheter. These devices inherently avoid excessive stress on the surrounding anatomical structures preventing from atrio-ventricular block problems. The material mostly used for this application is Nitinol, a shape memory super-elastic material, which allows for a total deformation recovery without any residual stress, decreasing the risk of fatigue fracture [2].

Materials and methods. We reproduced the structural finite element (FE) model of the self-expandable CoreValve© device, produced by Medtronic©, including both the stent and the prosthetic valve leaflets. A structural approach was adopted in order to reproduce the realistic behavior of the stent dynamics within a paradigmatic aortic root model [3]. Starting from the unloaded stent configuration, a crimping simulation was performed. Then, the deformed geometry was imported into the aortic root model following clinical-practice guidelines; once positioned, the stent expanded freely recovering its shape. Moreover, three different calcification patterns were reproduced on native aortic valve leaflets from ex-vivo measurement, in order to assess the performances of the device in an idealized pathological scenario. All the simulations

were run in the explicit finite element solver LS-DYNA© (LSTC, Livermore, CA, USA).

Results. After the crimping, the highest Von Mises stresses (603 MPa) were localized at the intersection between structs with the largest diameter, although remaining below the yield stress value (750 MPa) of the Nitinol model. Once deployed, the final stent configuration reported distortions due to the presence of the calcific deposits. Radial displacements, were compared with those obtained through simulations without the presence of calcifications. Their values the absolute differences were equal to: 0.56 mm, 0.22 mm and 0.34 mm respectively for each pattern. Mechanical Von Mises stresses computed on the valvular calcifications ranged between 0.198 MPa and 5.785 MPa.

Conclusion. This work showed the impact of aortic valve's calcifications on the final configuration of the implanted TAV and the influence on its dynamic behavior. Moreover, the thickness and the pattern of the calcific deposits proved to be the main factors that affect the behavior of the leaflet and its interactions with the stent structure. The proposed modeling approach may help to identify future improvements for the design and the development of thranscatether valvular properties.

[1] D. A. Wood et al, J Am Coll Cardiol (2012) 60(6): 483-492.

[2] S. Tzamtzis, MEP (2013), 35: 125-130.

[3] F. Sturla, MEP (2012), 135(12): 1721-1730.

N. V. DEREVIANKO [1]

One orthogonal trigonometric Schauder basis and local Besov spaces

[1] *Institute of Mathematics, Kyiv, Ukraine*
E-mail: nadyaderevyanko@gmail.com

The talk will focus on the problem to describe the local Besov spaces of functions [1] by conditions on the coefficients in a series expansion of their elements on some special orthogonal trigonometric Schauder basis [2].

This is a joint work with Jürgen Prestin (Universität zu Lübeck, Institut für Mathematik) and Vitalii Myronyuk (Institute of Mathematics of NAS of Ukraine).

[1] H.N. Mhaskar, J. Prestin, *J. Fourier Anal. Appl.* **11**, (2005), p. 353-373.
[2] J. Prestin., K.K. Selig, *Oper. Theory, Adv. Appl.* **121**, (2001), p. 402-425.

P. DENCKER [1], W. ERB [1]

Multivariate interpolation on Lissajous-Chebyshev nodes and applications in Magnetic Particle Imaging

[1] *Institute of Mathematics, University of Lübeck*
E-mail: dencker@math.uni-luebeck.de, erb@math.uni-luebeck.de

In this contribution, we analyse multivariate polynomial interpolation on Lissajous-Chebyshev node points in the context of approximation theory and and with respect to applications in Magnetic Particle Imaging. These non-tensor product node sets linked to the intersection and boundary points of Lissajous curves as well as to the singularities of Chebyshev varieties. After classifying multivariate Lissajous curves and the respective interpolation nodes, we derive a discrete orthogonality structure on these node sets. Using this discrete orthogonality structure, we are able to prove unique polynomial interpolation in appropriately defined spaces of multivariate Chebyshev polynomials. We show how this polynomial interpolant can be computed in an efficient way by using fast Fourier methods and how this interpolation theory can be applied in Magnetic Particle Imaging. Our results generalize corresponding interpolation and quadrature results for the Chebyshev-Gauß-Lobatto points in dimension one and the Padua points in dimension two.

G. FERNANDEZ [1], I. TERESHCHENKO [2]

Modeling of material and energy flows in the Metropolitan City of Milan, Italy using urban metabolism approaches

[1] *Politecnico di Milano, Milan, Italy*
E-mail: gabriela.fernandez@polimi.it
[2] *The National Technical University of Ukraine Kyiv Polytechnic Institute, Kyiv, Ukraine*
E-mail: tereshchenko.igor@gmail.com

A major challenge to urban sustainability research today is to understand the urban metabolic profile of cities and predict how cities with different socio-economic, demographic, and geographic characteristics interact with the natural environment in which they exist. Due to the increasing population growth in cities and high dense concentrations it is necessary to understand the complexity of the urban socio-economic phenomena, different forms of resource consumption and energy intensities in cities. Data was collected from public and private databases; scales of data included local, regional, national and global level. Infrared satellite imagery and economic variables were also used. The study applied mathematical modeling and energy flow simulation model approaches: 1. convection-diffusion model [1]; 2. quantitative network model and 3. neural network model, to capture the metabolic flow profile of a system between cities in the Metropolitan City of Milan, Italy.

The data analysis combined a set of statistical socio economic, material and energy flow data; and multi-parameter clustering analysis to demonstrate energy and demographic behavioral flow interconnections, similarities and differences of material and energy consumption flows within build clusters.

Applied, Group Method of Data Handling approach to forecast material and energy consumption, economic growth and the relationship of the data to understand the territorial metabolism [2] of a city through networks, economies and infrastructure.

[1] I. Tereshchenko, *International Journal of Innovative Technology and Research* **2**, (2014), p. 1237.

[2] G. Fernandez, *Abitare Insieme. Dimensione condivisa del progetto di futuro. Clean Edizioni* **3**, (2015), p. 29.

F. FILBIR [1]

Mathematics of photoacoustic tomography

[1] *Technische Universitaät München & Helmholtz Center Munich, Germany*
E-mail: filbir@helmholtz-muenchen.de

Photoacoustic tomography is a rapidly developing modality for in vivo imaging. The method is used in various fields like spectroscopy, microscopy, and biomedicine. Especially biomedical applications seem to attract increasing attention. The method is based on the generation of an acoustic wave due to absorption of energy. A very short laser pulse is sent to a probe where, triggered by the absorption of the in-falling radiation, a thermoelastic expansion of the tissue is initiated. This expansion creates a pressure wave which propagates through the probe and beyond. The corresponding acoustic signal is recorded by transducers which are distributed around the object. The aim is to reconstruct an image from these signals. The talk will provide an overview on the mathematical models used in photoacoustic tomography and some fundamental related results. Moreover, we will present several reconstruction techniques and a new exact inversion formula.

I. M. KARABASH [1, 2, 3]

Concentration inequalities for random Fourier series and related questions

[1] *Institute of Applied Mathematics and Mechanics of NAS of Ukraine, Slovyans'k, Ukraine*
[2] *Institute of Mathematics, the University of Lübeck, Germany*
[3] *Hausdorff Research Institute for Mathematics, Rheinische Friedrich-Wilhelms-Universität Bonn, Germany*
E-mail: i.m.karabash@gmail.com

Recently, we jointly with Jürgen Prestin have developed a method for the detection of exponential periodicities in a signal with a heavy-tailed noise [1]. One of the ways to measure the efficiency of the related

algorithm is to find the rate of convergence of estimators to the true parameters of the signal. The technique that is usually used for this purpose involves concentration inequalities, which in the present case are estimates on probabilities that trigonometric polynomials generated by the noise have norms greater than a certain growing constant. The talk will discuss difficulties in the derivation of such estimates and connections with other problems of Approximation Theory, like Remez inequalities.

[1] I. M. Karabash, J. Prestin, *arXiv preprint* arXiv:1512.08732, (2015), 18 p.

T. KATRII [1], A. YURCHENKO [1], F. CONSOLO [2],
O. M. SAVCHUK [1], G. B. FIORE [2], A. REDAELLI [2]

Characterization of acetylation of coagulation Factor II through a chromogenic assay

[1] *Taras Shevchenko National University of Kyiv, Ukraine*
E-mail: tetiana.katrii@gmail.com
[2] *Politecnico di Milano, Italy*
E-mail: filippo.consolo@polimi.it

1. Introduction It is known that thrombin is a potent platelet activator; thus, thrombin produced by activated platelets further increase the platelet activation (PA) level to expedite clot formation. Acetylated prothrombin (Ac-FII) can block thrombin-mediated PA feedback [1]. Ac-FII is the key element of the Platelet Activation State assay (PAS assay), based on the modification of the prothrombinase method to quantify in vitro the PA level [2]. In this context, the aim of our work was acetylation and characterization of the Ac-FII.

2. Methods 2.1 Acetylation**.** Prothrombin from human Plasma 71 μM (Calbiochem, USA) was firstly dialyzed against 0.1 M $NaHCO_3$pH 8.5. at 4°C to clean the FII. The dialysis solution was changed after 60 min for three times. Acetylation was made by incubating dialyzed FII with Sulfo-NHS-Acetate (Thermo Fisher Scientific, USA) at final concentration of 3 μM per 60 min at room temperature. The reaction was stopped by the addition of 2 M Tris-HCl, pH 8 and 0.2 M EDTA, 1/5 vol/vol each. Than gel-filtration of Ac-FII on Sephadex G25 column

(PD-10, Sigma-Aldrich, USA) was performed. A final volume of 5 ml of 17 μM Ac-FII was obtained. Ac-FII was diluted with $NaHCO_3$to achieve final 10 μM concentration, aliquoted in 50 μl tubes and sotred at -30°C until use to preserve stability.

2.2 Analysis of spontaneous activity of Ac-FII. Ac-FII was tested for potential spontaneous thrombin conversion activity using the PAS assay, which makes use of a thrombin specific chromogenic substrate (Chromozym-TH, Roche Life Science) to quantify thrombin. A model system was included, consisting in: i) Ac-FII 200 nM; ii) FXa 100 pM; iii) Chromozime-TH 0.3 mM; iv) HBS-BSA-EDTA buffer containing 20 mM HEPES, 130 mM NaCl, 0.1% BSA and 0.2 M EDTA. Incubation at 37 °C per 10 min was performed. Thrombin generation was quantified through spectrophotometric analysis over 8 min at an absorbance wavelength of 405 nm. Linear regression analysis of absorbance *vs* time data points was performed. The slope of the linear regression represents the amount of generated thrombin by spontaneous conversion of Ac-FII.

3. Results and Discussion According to PAS assay, Ac-FII did not reveal spontaneous activity; indeed, Ac-FII preserved its stability, i.e., was not converted in thrombin. As a result, the slope of the absorbance-time linear regression was quite zero (equal to 1.45e-05).

4. Conclusion According to our results, our acetylation protocol was extremely effective since it allowed to: i) inhibit spontaneous activity of Ac-FII; ii) measuring PA eliminating the thrombin positive feedback.

[1] Dougald M. Monroe, Maureane Hoffman, Harold R. Roberts. Platelets and Thrombin Generation. Arteriosclerosis, Thrombosis, and Vascular Biology. 2002.

[2] Jesty J, Bluestein D. Acetylated prothrombin as a substrate in the measurement of the procoagulant activity of platelets. Analytical Biochemistry. 1999.

[3] Valerio L, Consolo F, Bluestein D, Tran P, Slepian MJ, Redaelli A, Pappalardo F. Shear- mediated platelet activation in patients implanted with continuous flow LVADs: a preliminary studyutilizing the Platelet Activity State (PAS) assay. Conf Proc IEEE Eng.Med Biol Soc. 2015.

K. KELLER [1]

Dynamical Structure, Entropy and Data: Approaches and Perspectives

[1] *Institute of Mathematics, Luebeck, Germany*
E-mail: keller@math.uni-luebeck.de

Entropies are playing an increasing role in data analysis. Here various concepts and methods are utilized, with strong or less strong theoretical background. We address structural aspects of using entropies in the framework of dynamical systems and discuss perspectives of robust data analysis and reconstruction of dynamical structure. One aim is a better understandig of the relationship of the many entropies and entropy-like quantities used in practice.

Yu. KOLOMOITSEV [1]

New inequalities for moduli of smoothness in L_p, $0 < p < 1$

[1] *Institute of Applied Mathematics and Mechanics of NAS of Ukraine, Slov'yans'k, Ukraine*
E-mail: kolomus1@mail.ru

Let $f \in L_p[0,1]$, $0 < p \le \infty$, and $r \in \mathbb{N}$. The modulus of smoothness of order r of the function f is defined by

$$\omega_r(f,h)_p = \sup_{0<\delta<h} \|\Delta_\delta^r f(x)\|_{L_p[0,1-r\delta]},$$

where $\Delta_\delta^1 f(x) = f(x+\delta) - f(x)$ and $\Delta_\delta^r f(x) = \Delta_\delta^1 \Delta_\delta^{r-1} f(x)$.

It is well know that for any function f such that $f, f' \in L_p[0,1]$ with $p \ge 1$ one has

$$\omega_r(f,h)_p \le h\omega_{r-1}(f',h)_p. \tag{1}$$

In [1] it was shown that if $0 < p < 1$, then inequality (1) does not hold in general.

In the present talk, we will discuss how to estimate the modulus $\omega_r(f,h)_p$ via $\omega_{r-1}(f',h)_p$ in the case $0 < p < 1$.

[1] P. Petrushev, V. Popov, *Rational Approximation of Real Functions*, Cambridge University Press, Cambridge, 1987.

G. KRIUKOVA [1], S. PEREVERZYEV JR. [2], P. TKACHENKO [1]

Nyström type subsampling analyzed as a regularized projection

[1] *Johann Radon Institute for Computational and Applied Mathematics, Austrian Academy of Sciences*
E-mail: galyna.kriukova@ricam.oeaw.ac.at and pavlo.tkachenko@ricam.oeaw.ac.at
[2] *Institute of Mathematics, University of Innsbruck*
E-mail: sergiy.pereverzyev@uibk.ac.at

In the statistical learning theory the Nyström type subsampling methods are considered as tools for dealing with big data. In this paper we consider Nyström subsampling as a special form of the projected Lavrentiev regularization, and study it using the approaches developed in the regularization theory. As a result, we prove that the same capacity independent learning rates that are quaranteed for standard algorithms running with quadratic computational complexity can be obtained with subquadratic complexity by the Nyström subsampling approach, provided that the subsampling size is chosen properly. We propose a priori rule for choosing the subsampling size and a posteriori strategy for dealing with uncertainty in the choice of it. The theoretical results are illustrated by numerical experiments.

[1] G. Kriukova, O. Panasiuk, S.V. Pereverzyev, and P. Tkachenko. A linear functional strategy for regularized ranking. *Neural Networks* **1**, (2016), pp.26–35.

[2] G. Kriukova, S. Pereverzyev Jr., P. Tkachenko. Nyström type subsampling analyzed as a regularized projection. *Preprint-Series: Department of Mathematics - Applied Mathematics. Leopold-Franzens-Universität Innsbruck* (2016).

I. NESTERUK [1], A. REDAELLI [2], I. KUDYBYN [1],
B. SHEPETYUK [3]

The comparison of the efficiency of human motion (running, swimming, skiing, skating, cycling and rowing)

[1] *Institute of Hydromechanics, National Academy of Sciences of Ukraine, Kyiv, Ukraine*
[2] *Politecnico di Milano, Milan, Italy*
[3] *Yuriy Fedkovych Chernivtsi National University, Chernivtsi, Ukraine*

The criterion previously proposed by the authors to evaluate fish motion efficiency (I. Nesteruk, G. Passoni, A. Redaelli Shape of aquatic animals and their swimming efficiency. Journal of Marine Biology Volume 2014, Article ID 470715,) is here applied to assess human sport activities (running, swimming, skiing, skating, cycling and rowing). A significant amount of data on the velocity and body mass for both female and male athletes was collected. It was shown that running is much less effective than skating, cycling and swimming. The highest values of efficiency occurred in rowing and using purposely high speed bicycles due to shape optimization. Given the volumetric Reynolds number, the efficiency of female athletes is typically higher than male ones, especially concerning skating and swimming.

A. KYSELOVA [1], G. KYSELOV [1]

Context-Aware Approach for Management System

[1] *National Technical University of Ukraine "Kyiv Polytechnic Institute", Kiev, Ukraine*
E-mail: a.g.kyselova@gmail.com

In recent years, context-awareness has been the subject of growing attention in the area of ubiquitous computing because of its usefulness in several different applications. Context-aware resource management

system is an intelligent information system, which integrates the information from different heterogeneous sources. In the management system factors, influencing the decision-making, are context parameters. Context can be defined as any information that can be used to characterize the situation. Integration of information, obtained from heterogeneous sources, into the context produces a model of the current state of the real object, as well as reduces the amount of data to be processed, on the basis of which the control algorithms can generate numerous control solutions. This type of systems heavily relies on context-awareness and context prediction methods that utilize user related information [1].

[1] A. Kyselova. Context data analysis for microgrid control system *Visnyk NTUU KPI. Informatics, operation and computer science.* **58**, (2013), p. 46-50.

T. LOMAKO [1]

On growth of Lebesgue constants for convex polyhedra

[1] *Institute of Applied Mathematics and Mechanics of NAS of Ukraine, Slov'yans'k, Ukraine*
E-mail: tlomako@yandex.ru

Let B be a bounded set in $\mathbb{R}^d$. The following integral is called the Lebesgue constant for B

$$\int_{[0,2\pi)^d} \left| \sum_{k\in B\cap\mathbb{Z}^d} e^{i(k,x)} \right| \mathrm{d}x.$$

In the talk, we will present some new estimates of Lebesgue constants in the case when B is a convex polyhedron. Our results generalize and give sharper versions of the pioneering results of E.S. Belinsky [1], A.A. Yudin and V.A. Yudin [2], and M. Ash [3].

This is a joint work with Yurii Kolomoitsev (Institute of Applied Mathematics and Mechanics of NAS of Ukraine, Slov'yans'k).

[1] E. S. Belinsky, *Metric Questions of the Theory of Functions and Mappings*, Naukova Dumka, Kiev, (1977), p. 19–39.

[2] A. A. Yudin, V. A. Yudin, *Mat. Zametki* **37**, (1985), p. 220–236.

[3] M. Ash, *J. Fourier Anal. Appl.* **16**, (2010), p. 1053–1069.

A. V. KLEVTSOVSKIY [1], T. A. MEL'NYK [1]

Asymptotic approximations of solutions to boundary-value problems in thin aneurysm-type domains

[1] *National Taras Shevchenko University of Kyiv, Ukraine*
E-mail: avklevtsovskiy@gmail.com, melnyk@imath.kiev.ua

The mathematical study of blood flows in vessels is an urgent problem of the next years. Especial interest is the investigation of the influence of a local geometrical heterogeneity in vessels on the blood flow. This is both an aneurysm (a pathological extension of an artery like bulge) and a stenosis (a pathological restriction of an artery). The understanding of the local haemodynamics can have useful applications in medicine.

In [1] the authors classified 12 different aneurysms and proposed computational approach for this study. The aneurysm models have been meshed with 800,000 – 1,200,000 tetrahedral cells containing three boundary layers. However, as was noted by the authors, the question *how to model blood flow with sufficient accuracy is still open.*

In our talk we present a new asymptotic method for boundary-value problems in thin aneurysm-type domains, which can give the answer. The method is the further development of the asymptotic method proposed in our paper [2].

[1] Ø. Evju, K. Valen-Sendstad, K.A. Mardal, A study of wall shear stress in 12 aneurysms with respect to different viscosity modelsand flow conditions. *Journal of Biomechanics*, **46** (2013), p. 2802–2808.

[2] A.V. Klevtsovskiy, T.A. Mel'nyk, Asymptotic expansions of the solution of an elliptic boundary-value problem for a thin cascade domain, *J. Math. Sci.* **198** (2014), p. 303–327.

M. MÜNTER [1], C. BUJ [1], R. BRINKMANN [1,2]

Resolution and contrast of an optical full-field holographic system for fast non-contact Photoacoustic Tomography

[1] *Medical Laser Center Lübeck GmbH, Lübeck, Germany*
E-mail: muenter@mll.uni-luebeck.de; buj@mll.uni-luebeck.de; brinkmann@mll.uni-luebeck.de
[2] *Institute of Biomedical Optics, Universität zu Lübeck, Lübeck, Germany*
E-mail: brinkmann@bmo.uni-luebeck.de

The optical excitation of embedded absorbers leads to the emission of a thermoacoustic pressure wave, which transiently alters the surface topography. The resulting nanometer surface displacements are recorded by means of full-field holography. First studies about penetration depth, resolution and contrast using silicone phantoms with embedded black silicone absorbers are presented. For excitation, a Q-switched Nd:YAG-laser (1064 nm, 10 ns) is used. For detection, a Q-switched solid-state laser (532 nm, 10 ns) in double pulse mode served for illumination of the surface, pre and after excitation respectively. Surface changes lead to a phase shift of the backscattered light. An area of 0.6 cm2 is recorded by a 2 kHz CMOS-camera. Phase differences between subsequent images can be evaluated with respect to geometrical surface displacement. The axial resolution of the method is measured to be below 2 nm. By a repetitive excitation and an increasing time delay between excitation- and detection pulse, the altering topography is sampled with up to 40 MHz. The detection process of a time period of 10 s can be done within 200 ms. The detected data is processed for filtered back projection reconstruction in order to obtain the absorbers location. The reconstruction of 300 m absorbers in porcine skin phantoms in several millimeters depth is presented. Studies about resolution and contrast in dependence of the optical sensitivity and penetration depth will be discussed. This very fast optical full-field holographic non-contact detection method for Photoacoustic Tomography opens new in vivo applications without anesthesia where clinical contact detectors cant be used.

[1] Jens Horstmann, Hendrik Spahr, Christian Buj, Michael Münter, Ralf Brinkmann *Full-field speckle interferometry for non-contact photoacoustic tomography, Physics in Medicine and Biology* **60**, (2015), p. 4045-4058.

V. V. MYRONYUK [1]

Orthogonal trigonometric Schauder basis in the space $C(\mathbb{T}^2)$

[1] *Institute of Mathematics of NASU, Kyiv, Ukraine*
E-mail: vetalmyronjuk@ukr.net

The talk is based on a joint research with Nadiia Derevianko (Institute of Mathematics of NASU, Kiev, Ukraine) and Jürgen Prestin (Institute of Mathematics, University of Lübeck, Germany).

We construct an orthogonal trigonometric Schauder basis in the space $C(\mathbb{T}^2)$, which has a small growth of the polynomial degree. The construction is mainly based on an anisotropic periodic multiresolution analysis in $L_2(\mathbb{T}^2)$, which was recently developed in [1] and [2]. The polynomial degree is considered in the terms of l_1- and l_∞-norm.

[1] D. Langemann, J. Prestin, *Appl. Comput. Harm. Anal.* **28**, (2010), p. 46–66.
[2] R. Bergmann, J. Prestin, *J. Fourier Anal. Appl.* **21**, (2015), p. 342–369.

V. NAUMOVA [1], M. GRASMAIR [2]

Conditions on optimal support recovery in unmixing problems by multi-penalty regularization

[1] *Simula Research Laboratory, Norway*
E-mail: valeriya@simula.no
[2] *Norwegian University of Science and Technology, Norway*
E-mail: markus.grasmair@math.ntnu.no

Inspired by several real-life applications in audio processing and medical image analysis, where the quantity of interest is generated by several sources to be accurately modeled and separated, as well as by recent advances in regularization theory and optimization, in this talk we present the conditions on optimal support recovery in inverse problems of unmixing type by means of multi-penalty regularization.

We present a regularization functional composed of a data-fidelity term, where signal and noise are additively mixed, a non-smooth, convex, sparsity promoting term, and a quadratic penalty term to model the noise. We prove not only that the well-established theory for sparse recovery in the single parameter case can be translated to the multi-penalty settings, but we also demonstrate the enhanced properties of multi-penalty regularization in terms of support identification compared to sole ℓ_1-minimization. We additionally confirm and support the theoretical results by extensive numerical simulations, which give a statistics of robustness of the multi-penalty regularization scheme with respect to the single-parameter counterpart. Eventually, we illustrate a significant improvement in performance compared to standard ℓ_1-regularization for compressive sensing problems considered in our experiments.

I. NESTERUK [1], A. REDAELLI [2]

Cooperation between Politecnico di Milano and the Institute of Hydromechanics NASU in the EUMLS Project Framework

[1] *Institute of Hydromechanics, Kyiv, Ukraine*
E-mail: inesteruk@yahoo.com
[2] *Politecnico di Milano, Milan, Italy*
E-mail: alberto.redaelli@polimi.it

The cooperation between Politecnico di Milano and the Institute of Hydromechanics NASU was focused on 5 different areas: 1) Study of the unsteady blood flow in aorta, pulmonary artery and ventricles based on the 4D MRI data. A new algorithm based on the properties of the HagenPoiseuille flow has been proposed for the segmentation of blood vessels, for the calculation of the flow characteristics and for flow visualization. The method doesnt need any manual segmentation of the vessel shape. Only one point located inside the vessel is necessary to start the calculation up- or downstream to the blood flow. The time cost is approximately 5-6 seconds for one section (giving 1 minute for a 20 mm vessel length). The algorithm was applied to 25 subjects (20 BAV patients and 5 healthy volunteers). 2) Experimental study of the pressure fluctuations in the steady and the unsteady flow through a prosthetic bileaflet mitral valve with the use of sensors developed in IHM and

the experimental facilities of Polimi. 3) Development of a novel method to assess the motion efficiency of animals and vehicles to be applied to aquatic, flying and running animals and for human sport activities (running, swimming, skiing, skating, cycling and rowing). 4) Investigation of the effects of shear stress level, exposure time and stress accumulation of platelets in two types of micro-channels through the use of probability density functions and their integrals. The obtained analytical formulae were compared with CFD simulation results. 5) Adapting denoising techniques to Echo and Phase-Contrast image datasets in order to reduce/eliminate artifacts and make them more suitable for segmentation and post-processing.

V. OVERKO [1]

Features of the blood flow in the curved vessels and the arterial bifurcation

[1] *Institute of Applied Mathematics and Mechanics, Slovyansk, Ukraine*
E-mail: overko.vitalij@yandex.ua

Mathematical simulation of the blood flow in the pathologically curved blood vessels was performed. Influence of degrees of the curvature by the intensity and the features of the secondary and the reverse blood flow in the vessels at different times cardiac cycle was determined. The loss pressure for different level of the pathological curvature was defined. The hydrodynamics of blood flow in the bifurcation of the carotid artery to the mathematical proof of the differential approach to the choice of the method of operation and optimizing the way the eversion carotid endarterectomy (ECEn) was investigated. Computer simulation showed that the formation of a new anastomosis the flow rate of blood flow in the ICA and the ECA have remained practically unchanged compared with the cost of not operated in the branches of the bifurcation, and surgery without the use of ECEn leads to significantly redistribution of blood flow. The calculation and visualization of blood flow in the dichotomies at different levels branching arteries was performed. Computer simulations showed that two types of dihotomy perform a complex function: regulate the flow properties of the blood and affect on the velosity of

blood flow. This shows that building a model of the human arterial system founded on criteria of optimality based on the principle of minimum hydrodynamic resistance impossible.

[1] David F Rogers and J. Alan Adams. Mathematical Elements for Computer Graphics. McGraw- Hill, Inc., second edition, 1990.

[2] B. Hahn. D.T. Valentine, Essential MATLAB for Engineers and Scientists, Elsevier (Third edition), 2007.

[3] Webb S., The Physics of Medical Imaging, Institute of Physics Publishing, London.

[4] Brott Th. G. Halperin J. L., Abbara S, et al. Guideline on the Management of Patients With Extracranial Carotid and VertebralArtery Disease. Stroke. 2011; 42:e464-e540.

[5] Kumar Rajamani and Seemant Chaturvedi. Stroke Prevention-Surgical and Interventional Approaches to Carotid Stenosis // Neurotherapeutics. 2011. 8(3): 503514.

S. V. PEREVERZYEV [1]

Multi-penalty regularization in reconstruction of causality network

[1] *Johann Radon Institute for Computational and Applied Mathematics, Austrian Academy of Sciences*
E-mail: sergei.pereverzyev@ricam.oeaw.ac.at

The talk can be seen as an introduction to the Research Task 3.1 "Regularization methods for causality detection" of H2020-MSCA-RISE-Project AMMODIT and is based on the results obtained in cooperation with University of Natural Resources and Life Sciences, Vienna, Simula Research Laboratory, Norway, and University of Innsbruck.

The talk is about a new method for detecting relevant variables from a priori given high-dimensional data under the assumption that input-output dependence is described by a nonlinear function depending on a few variables.

The method is based on the inspection of the behavior of discrepancies of a multi-penalty regularization with a component-wise penalization for small and large values of regularization parameters.

A justification of the proposed method is provided under a certain condition on sampling operators. The effectiveness of the method is demonstrated in the example with synthetic data and in the reconstruction of gene regulatory networks. In the latter example, the obtained results provide a clear evidence of the competitiveness of the proposed method.

[1] K. Hlavackova-Schindler, V. Naumova, S. Pereverzyev Jr. Multi-penalty regularization for detecting relevant variables. *Preprint-Series: Department of Mathematics-Applied Mathematics. Leopold-Franzens-Universität Innsbruck* **11**, (2014).

O. DOVGOSHEY [1], E. PETROV [1], H.-M. TEICHERT [2]

Rigidity of finite ultrametric spaces

[1] *Institute of Mathematics, Kyiv, Ukraine*
E-mail: aleksdov@mail.ru, eugeniy.petrov@gmail.com
[2] *Institute of Mathematics, University of Lübeck, Lübeck, Germany*
E-mail: teichert@math.uni-luebeck.de

A metric space X is rigid if the isometry group of X is trivial. The finite ultrametric spaces X with $|X| \geq 2$ are not rigid since for every such X there is a self-isometry having exactly $|X| - 2$ fixed points. Using the representing trees we characterize the finite ultrametric spaces X for which every self-isometry has at least $|X| - 2$ fixed points.

[1] O. Dovgoshey, E. Petrov, and H. M. Teichert, *How rigid the finite ultrametric spaces can be?*, http://arxiv.org/abs/1511.08133.

A. B. PIEK [1], K. KELLER [2]

A distance measure for ordinal patterns

[1] *Institut für Mathematik, Lübeck, Germany*
E-mail: piek@math.uni-luebeck.de
[2] *Institut für Mathematik, Lübeck, Germany*
E-mail: keller@math.uni-luebeck.de

Ordinal time series analysis has recently found many applications in science and medicine. Here, the distribution of certain ordinal patterns – described in terms of permutations – within a time series is from particular interest. For deeper insights, it can be useful to cluster patterns that are similar in a certain sense. To formally describe the similarity, there is a need for an appropriate distance measure, which in contrast to many known "combinatorical" measures also fits geometric structure.

We introduce a new distance measure that describes the similarity of ordinal patterns regarding geometry and present several properties of that measure.

A. Yu. PILIPENKO [1]

On a selection problem for small noise perturbation of unstable dynamical systems

[1] *Institute of Mathematics, Kyiv, Ukraine*
E-mail: apilip@imath.kiev.ua

Assume that a dynamical system is given by an ordinary differential equation

$$X_t = x + \int_0^t b(X_s)ds, t \geq 0 \tag{1}$$

where $x \in \mathbb{R}^d$ and $b : \mathbb{R}^d \longrightarrow \mathbb{R}^d$ is a bounded, continuous vector field.

If b satisfies a Lipschitz condition, it is well-known that there exists a global unique solution to (1). If b is not Lipschitzian, then Peano's theorem still ensures existence of solutions but uniqueness may fail.

We study a limit behavior of a small noise perturbation of (1) given by the following stochastic equation

$$X_t^\varepsilon = x + \int_0^t b(X_s^\varepsilon)ds + \varepsilon w(t),\ t \geq 0, \tag{2}$$

where $w(t), t \geq 0$ is a Brownian motion. Note that there exists a unique solution to (2) by Veretennikov's theorem [1] even if b is discontinuous.

We interpret the corresponding limit of $\{X_\varepsilon\}$ as a natural selection for a solution of (1).

[1] A.Yu. Veretennikov, *Theory Probab. Appl.* **24**, N 2, (1979), p. 354–366.

F. STURLA, R. VISMARA, E. VOTTA, G. B. FIORE, A. REDAELLI [1]

In vitro and in silico evaluation of the Mitraclip® system

[1] *DEIB, Politecnico di Milano, Milano, Italy*
E-mail: francesco.sturla@polimi.it, riccardo.vismara@polimi.it, emiliano.votta@polimi.it, gianfranco.fiore@polimi.it, alberto.redaelli@polimi.it

Mitral regurgitation is the most prevalent heart valve disease in the western population. When severe, it requires surgical treatment, repair being the preferred option. Among possible surgical options, the edge-to-edge repair technique treats mitral regurgitation by suturing the leaflets together and creating a double-orifice valve. Due to its relative simplicity and versatility, it has become progressively more widespread. Recently, its percutaneous version has become feasible, and has raised interest thanks to the positive results of the Mitraclip® device which has demonstrated in a randomized clinical trial (EVEREST) not to be inferior to standard surgery.

In general, percutaneous heart valve interventions are gaining attention as an alternative to open surgery for those patients not referred for surgery and for elder population, and, although in their infancy, the field is developing rapidly and there is a strong push from the clinical and industrial stakeholders towards the refinement of the current adopted tools and procedures.

In this scenario, at our institution, we are developing specific tools for the in vitro and in silico analysis and test of percutaneous devices.

Concerning in vitro tools, we have recently developed a passive beating heart platform, able to replicate the in vivo functioning of left heart valves under physiological conditions by using a swine heart connected to a piston pump and proper pre- and after-loads. This test bench has been used to test the new generation Mitraclip® device and is currently used for surgical training.

Concerning computational tools, we have developed a simulation protocol to evaluate the effects of Mitraclip® device use on patient-specific models. From cine-cardiac magnetic resonance datasets, we derive image-based structural finite element models accounting for the patient-specific 3D geometry of the valve, including leaflet compound curvature pattern, patient-specific motion of annulus and papillary muscles, as well as hyperelastic and anisotropic mechanical properties of tissues. The valve behavior is then simulated throughout the entire cardiac cycle before and after Mitraclip® implantation, assessing the biomechanical impact of the procedure. In this way detailed information are extracted concerning systolic leaflets coaptation area, diastolic orifice area, and leaftlet stresses throughout the cardiac cycle, both under ideal device use and suboptimal use (partial grasp, leaflet misapposition, Mitraclip® mispositioning).

D. KÜPPER, A. KVÆRNØ [1], A. RÖSSLER [2]

Strong SRK methods for SDAEs of index 1 with scalar noise

[1] *Department of Mathematical Sciences, Norwegian University of Science and Technology, Norway*
E-mail: anne.kvarno@math.ntnu.no
[2] *Institute of Mathematics, Universität zu Lübeck, Germany*
E-mail: roessler@math.uni-luebeck.de

We consider the problem of numerical strong approximations for solutions of stochastic differential-algebraic equations (SDAEs) which are of index 1 and driven by a scalar Wiener process. Therefore, we discuss stiffly accurate SRK methods for mean-square approximations of orders 0.5 and 1. As the main advantage, the stochastic Runge-Kutta

(SRK) methods do not involve any pseudo-inverses or projectors for the numerical solution of the problem.

A. G. RUDNITSKII [1]

3D segmentation and denoising of anatomical structures via fractal and morphological filtering

[1] *Institute of Hydromechanics, Kyiv, Ukraine*
E-mail: rudnitskii@mail.ru

During the previous decades, vast improvements in information technology have led to significant enhancements in the field of medical imaging. Magnetic resonance imaging, computed tomography, positron emission tomography and ultrasound imaging have been adopted for diagnostic of many types of diseases, for wathing of the evolution of the treatment and choosing of the most adequate therapy. However, the presence of masking structures, noise and blur, the variability of tissues and biological shapes make the analysis of medical images a very hard task. This problem is especially important in the case of 3-dimensional denoising and segmentation.

In this paper for solving of this problem in addition to classic mathematical statistic were used relatively new methods - the fractal theory [1] and mathematical morphology approach [2]. Using of this methods together forms an interesting and powerful tool for complex processing data quantification.

Fractals give the potential for a richer description of the examining images. Fractal dimension is a quantitative descriptor that was used to identify the features of distinct components and tissues with different morphological traits and functional peculiarities. Morphological image processing is particularly good at extracting image features whose shape is known a priori, in particular, for detecting quasi-linear shapes such as vessels in an image or specific types of noises.

Were got results of denoising, edge detection and segmentation mitral leaflets and aorta for real 3D echo and phase-contrast data. Were stated that in 3D cases the combination of 3D ordering filtering, fractal segmentation and mathematical morphology give promising results.

[1] S. Kido, K. Kuriyama, M. Higashiyama, T. Kasugai, and C. Kuroda J. *J. Comput. Assist. Tomogr.* **27**, (2003), pp. 56-61.

[2] I. Zingman, D. Saupe, K. Lambers *Journal Of Computer Science And Applications*, **6(2)**, (2013), pp. 161-165.

M. SELMI [1], G. TASCA [2], E. VOTTA [1], F. STURLA [1], A. GAMBA [2], A. REDAELLI [1]

Aortic Root Biomechanics Following David and Sleeve Procedures: A Finite Element Analysis

[1] *Department of Electronics, Information and Bioengineering, Politecnico di Milano, Milan, Italy*
[2] *Division of Cardiac Surgery, Ospedale A. Manzoni, Lecco*
E-mail: matteo.selmi@mail.polimi.it

Background. Aortic root (AR) aneurysm is a local enlargement of the Valsalva sinuses portion, which can lead to an aortic insufficiency (AI). If the valve's tissue is not jeopardized, AI can be treated with valve-sparing techniques in order to replace the aneurysmatic aortic wall with a prosthetic graft preserving the native valve. The two principal procedures were originally implemented by David (*reimplantation*) and Yacoub (*remodeling*). Although they have shown excellent long-term results, they are still technically demanding. Recently, a simpler procedure, namely Sleeve technique, has been proposed with encouraging early-term outcomes [1]. It consists in "wearing" the prosthesis around the native vascular tissue, without removing both the valve and the Valsava sinuses. The aim of the proposed study was to reproduce this new technique on an aneurysmatic AR through computational modeling, so to assess its biomechanical performances in comparison with the traditional David procedure.

Materials and methods. The paradigmatic aneurysmatic AR finite element model was built accounting for the anatomical asymmetry, and for the non-linear and anisotropic mechanical properties of the components of the human aortic tissues. The Sleeve and David model were implemented considering the realistic mechanical response of the graft and its interaction with surrounding native tissues (e.g. stitches). A

comparative analysis was therefore carried out: the outcomes of the Sleeve and David techniques were assessed simulating the aortic root biomechanics throughout two consecutive cardiac cycles (ABAQUS Explicit, SIMULIA, Dassault Systèmes, USA).

Results. As compared to the David model, the Sleeve technique induced lower maximum stresses on the aortic valve (-13.8%, -6.7%, -12.5% on the right, non-coronary and left leaflet, respectively), at the peak of aortic transvalvular pressure. Indeed, during diastole, their value, averaged over the leaflets, was 35% lower in the Sleeve model. Furthermore, the native valve resuspension within the graft in the David procedure induced higher local stresses near the commissures (369 kPa, in contrast with 208 kPa in the Sleeve model). Both the sparing models provided comparable results in terms of valvular kinematics.

Conclusions. The Sleeve model highlighted no intrinsic structural problems or abnormal stresses potentially undermining the durability of the procedure. Preserving the aortic sinuses within the graft better restored physiologic-like biomechanics of AR [2]. The direct interaction between the valve and the prosthesis might explain why David model showed the highest local stress at the level of surrounding structures attachment.

[1] P.J. Hess et al., *Ann Thorac Surg*, (2009), 87(4): 1161-8.

[2] S. Katayama et al., *J Thorac Cardiovasc Surg*, (2008), 136(6): 1528-35.

V. SEMENOV [1]

Method of Blind Source Separation for QPSK signals

[1] *Scientific and Production Enterprise "Delta", Kyiv, Ukraine*
Institute of Hydromechanics of NASU, Kyiv, Ukraine
E-mail: mlev@bk.ru

The problem of blind source separation (see e.g. [1]) has a lot of applications in biomedical engineering, telecommunications etc. The basic statement of problem is as follows. Suppose we have one sensor receiving signals from two sources. The observation signal $x(t)$ corrupted by additive noise $w(t)$ is represented as

$$x(t) = s_1(t) + s_2(t) + w(t),$$

where $s_k(t)$, $k = 1, 2$ are the signals from different sources. The goal is to restore original signals $s_1(t)$, $s_2(t)$. In our investigation we generalize approach proposed in [2] for the case of QPSK (quadrature phase shift keying) signals having the following form:

$$s_k(t) = a_k e^{i\phi_k} \sum_{n=-\infty}^{\infty} y_k(n) g(t - nT_s - \tau_k),\ k = 1, 2,$$

where $y_k(n)$ are the information QPSK (i.e. taking each time one of four possible values) sequences that have to be estimated; $g(t)$ is a total channel response; T_s is a sampling (discretization) period; a_k, ϕ_k and τ_k are signal's amplitudes, phases and time shifts respectively. We also introduce the estimation contour of parameters a_k, ϕ_k, τ_k into the structure of separation algorithm. The performance of resulting method is demonstrated for various noise conditions.

[1] A. Hyvarinen, J. Karhunen, E. Oja, *Independent Components Analysis*, Wiley, New York, 2001.

[2] V. Gouldieff, J. Palicot, MISO Estimation of Asynchronously Mixed BPSK Sources, *Proc. IEEE Conf. EUSIPCO* (2015), p. 369-373.

E. V. SEMENOVA [1], H. L. MYLEIKO [1]

Informational efforts for solving severely ill-posed problems

[1] *Institute of Mathematics, Kyiv, Ukraine*
E-mail: semenovaevgen@gmail.com, anna_mileyko@ukr.net

We consider the issue of informational complexity for an integral equation of the first kind

$$Ax = f, \tag{1}$$

where $Ax(t) = \int_0^1 a(t, \tau)x(\tau)d\tau, \quad t \in [0, 1]$, is acting continuously in $L_2 = L_2(0, 1)$. Suppose that Range(A) is not closed in L_2, $f \in$ Range(A) and exact solution $x^\dagger$ belongs to the set of smooth functions $M_p(A) := \{u : u = \ln^{-p}(A^*A)^{-1}v, \|v\| \leq \rho\}$, where $\rho, p > 0$ are some positive parameters. Let $f_\delta \in L_2$ such that $\|f - f_\delta\| \leq \delta$.

The minimal radius of Galerkin information for different discretization schemes is found for solving severely ill-posed problems (1) with

smooth operators A and smooth solutions $x^\dagger \in M_p(A)$. In our investigation we consider a priori and a posteriori case for choosing regularization parameter. It is proved that proposed approaches save both the order for minimal radius of Galerkin information and the accuracy of the projection methods as in [1].

[1] S.G. Solodky, G.L. Myleiko, *Journal of Inverse and Ill-Posed Problems* **5**, (2014), p. 735–757.

A. L. SHYDLICH [1]

Nonlinear approximation of the classes $\mathcal{F}^{\psi}_{q,r}$ of functions of several variables in L_p

[1] *Institute of Mathematics of NASU, Kyiv, Ukraine*
E-mails: shidlich@gmail.com, andy709@list.ru

Let L_p, $p \in [1,\infty]$, be the space of all Lebesgue-measurable on $\mathbb{R}^d$ 2π-periodic in each variable functions f with the usual norm $||f||_{L_p}$. Let also $\psi = \psi(t)$, $t \geq 1$, be a positive decreasing function, $\psi(0) := \psi(1)$.

We investigate asymptotical behavior of some important nonlinear approximative characteristics of the classes of functions of several variables $\mathcal{F}^{\psi}_{q,r} := \left\{ f \in L_1 \ : \ ||\{|\widehat{f}(k)|/\psi(||k||_{l_r})\}_{k\in\mathbb{Z}^d}||_{l_q(\mathbb{Z}^d)} \leq 1 \right\}$, where $q, r \in (0,\infty]$, $\widehat{f}(k)$, $k \in \mathbb{Z}^d$, are the Fourier coefficients of f and $||\cdot||_{l_p}$ is the usual norm of the sequence spaces l_p.

For any $f \in L_p$, we set $\sigma_m(f)_{L_p} := \inf_{\gamma_m, c_k} ||f(\cdot) - \sum_{k\in\gamma_m} c_k e^{i(k,\cdot)}||_{L_p}$, where γ_m is a collection of m different vectors from the set $\mathbb{Z}^d$ and c_k are arbitrary real numbers.

Theorem 1 *Assume that $p, r \in [1,\infty]$, $q \in (0,\infty)$, $\psi = \psi(t)$, $t \geq 1$, is a convex decreasing to zero function such that $\psi(t)/\psi(2t) \leq K_1$. Then for any $1 \leq p \leq 2$ and $0 < q \leq \frac{p}{p-1}$,*

$$\sigma_m(\mathcal{F}^{\psi}_{q,r})_{L_p} := \sup_{f\in\mathcal{F}^{\psi}_{q,r}} \sigma_m(f)_{L_p} \asymp \psi(m^{\frac{1}{d}}) m^{\frac{1}{2}-\frac{1}{q}}. \tag{1}$$

If $1 < p \leq 2$ and $q > \frac{p}{p-1}$, then relation (1) holds in the case

$$t|\psi'(t)|/\psi(t) \geq K_2 > \beta, \quad \psi'(t) := \psi'(t+), \tag{2}$$

where $\beta = d(\frac{1}{2} - \frac{1}{q})$. If $2 < p \leq \infty$, then relation (1) holds for functions ψ satisfying condition (2) with $\beta = d(1 - \frac{1}{q})_+$.

For $\psi(t) = t^{-\alpha}$, $\alpha > 0$, and $r = \infty$ relation (1) was obtained in [1].

[1] R.A. DeVore, V.N. Temlyakov, Nonlinear approximation by trigonometric sums, *J. Fourier Anal. Appl.*, **2**, No. 1 (1995), P. 29–48.

S. V. SIRYK [1], N. N. SALNIKOV [2]

Weight functions and computational schemes of the Petrov-Galerkin FEM for convection-diffusion problems

[1] *National Technical University of Ukraine "Kyiv Polytechnic Institute"*
E-mail: siryksv@gmail.com
[2] *Space Research Institute of NAS of Ukraine*
E-mail: salnikov.nikolai@gmail.com

A correct choice of the weight functions in the finite-element Petrov-Galerkin method (PGM) plays an important role in numerical solution of convection-diffusion problems since it prevents spurious oscillations in numerical solutions and stabilizes results while maintaining acceptable accuracy. New classes of weight functions in PGM for solving one-, two- and three-dimensional convection-diffusion problems were proposed and analyzed in [1, 2, 3, 4, 5]. These weight functions were later successfully applied for numerical solving of various unsteady convection-diffusion-reaction problems (both linear and nonlinear, including Burgers, hydrodynamical and MHD systems) [1, 3, 5, 6]. Some new estimates of PGM (in H^1, L_2 and C) for steady 1D convection-diffusion equations were obtained in [7] and generalized later for problems with reaction terms in [8]. Various aspects of the mass lumping technology were considered in [9, 10]. Current report presents a brief overview of some results of the papers mentioned above.

[1] N.N. Salnikov, S.V. Siryk, *Cybernetics and Systems Analysis,* **50** (5), (2014), P. 805-814.

[2] N.N. Salnikov, S.V. Siryk et al., *Journal of Automation and Information Sciences,* **42** (6), (2010), P. 67-83.

[3] S.V. Siryk, N.N. Salnikov, *Journal of Automation and Information Sciences,* **44** (1), (2012), P. 50-67.

[4] S.V. Siryk, N.N. Salnikov et al., *USiM,* **1**, (2014), P. 38-47, (in Russian).

[5] S.V. Siryk, *Math. Machines and Systems,* **4**, (2014), P. 139-155, (in Russian).
[6] N.N. Salnikov, S.V. Siryk et al., *USiM,* **4**, (2014), P. 23-32, (in Russian).
[7] S.V. Siryk, *Cybernetics and Systems Analysis,* **50** (2), (2014), P. 278-287.
[8] S.V. Sirik, *Ukrainian Mathematical Journal,* **67** (7), (2015), P. 1062-1090.
[9] S.V. Siryk, *Cybernetics and Systems Analysis,* **49** (5), (2013), P. 774-784.
[10] S.V. Siryk, N.N. Salnikov, *Reports of NASU,* **5**, (2014), P. 39-44, (in Russian).

S. A. STASYUK [1]

Nonlinear trigonometric approximation for functions with generalized mixed smoothness

[1] *Institute of Mathematics, Kyiv, Ukraine*
E-mail: stas.serg.a@gmail.com

We study the behavior of nonlinear trigonometric approximations for functions with generalized mixed smoothness (including small mixed smoothness) of Nikol'skii–Besov type classes and some other classes related to them. The investigated behavior of these approximative characteristics is described by the exact order estimates. These results supplement and extend known results which were obtained by Romanyuk [1], Temlyakov [2] and were published in recent survey [3].

[1] A. S. Romanyuk, *Izv. Math.* **67**, (2003), p. 265-302.
[2] V. N. Temlyakov, *Sb. Math.* **206**, (2015), p. 1628-1656.
[3] D. Dinh, T. Ullrich, V. N. Temlyakov, *arXiv:1601.03978v1 [math.NA]*, p. 154.

Y. S. SULEMA [1], Y. V. VALCHUK [1]

Brain tissue image adjustment method

[1] *National Technical University of Ukraine "Kyiv Polytechnic Institute", Kyiv, Ukraine*
E-mail: sulema@pzks.fpm.kpi.ua

An analysis of tissue images, in particular a search of specific features in them, has a significant value for brain researches. However the challenge for the comparative analysis consists in a difference in image types, used stains and conditions of the experiment fulfillment. The proposed method is focused on the adjustment of image quality; first of all, its contrast and color gamut. The method enables the normalization of pixel values of a given image series according to a certain template image. The proposed method is realized by the set of MATLAB functions, organized as a toolbox.

The research is carried out within the cooperation with the research group of Prof. Jan G. Bjaalie, Neural Systems Laboratory, Institute of Basic Medical Sciences, University of Oslo, Norway.

I. TERESHCHENKO [1]

Construction of spatial model of cervical vessels based on MRI images

[1] *The National Technical University of Ukraine Kyiv Polytechnic Institute, Kyiv, Ukraine*
E-mail: tereshchenko.igor@gmail.com

There are a number of three-dimensional human organ models that contribute to the creation of personalized medicine, as they facilitate disease diagnosis, planning of surgical interventions, and predicting treatment outcomes [1]. This study, proposed methods for deriving individual vessels geometry using MRI images.

As original images are not appropriate for spatial model reconstruction due to different kinds of noises and insufficient information on vessel behavior between different layers, the study applied additional techniques of image filtration and recognition based on artificial neural networks.

In this work, three-dimensional models of vessels were reconstructed from serial MRI images on two clinical patients. Texture classification by neural network allowed to make segmentation not only by pixel brightness, but also by the structure of biological tissue. This enabled us to determine the inner and outer surfaces of the vessels. This approach allowed segment areas with abnormal structure to be utilized as an additional tool for diagnostic.

In the paper, built surfaces of vessel behavior in different time steps allowed for calculating its dynamic motion. Missed information in the bifurcation point is restored due to separate modeling of the vessels central line and shape movement. In addition, static images of full problem areas were used to help identified missed information.

Models reconstructed from this image-based information can be subjected to computational hemodynamic analysis, and are more patient oriented, compared to an idealized model.

[1] S. Jaques, *Journal of Vascular Surgery* **28**, (1998), p. 143.

I. NESTERUK[1], F. PIATTI[2], A.REDAELLI[2], L. TERESHCHENKO[1], F.STURLA[2], S. PIROLA[2,3], M. BISSEL[4]

Application of the hydrodynamics - based algorithm for segmentation of aorta, pulmonary artery, left and right ventricles with the use of 4D MRI data

[1] *Institute of Hydromechanics, Kyiv, Ukraine*
E-mail: litere70@yahoo.com; inesteruk@yahoo.com
[2] *Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Milan, Italy*
E-mail: filippo.piatti@polimi.it; francesco.sturla@polimi.it; alberto.redaelli@polimi.it
[3] *Department of Chemical Engineering, Imperial College London, South Kensington Campus, UK*
E-mail: selene.pirola@mail.polimi.it
[4] *Division of Cardiovascular Medicine, Radcliffe Department of Medicine, University of Oxford, UK*

4D flow MRI can be used to visualize in-vivo blood flow in several complex cardiovascular diseases, e.g. aortic coartaction-dissection and valve stenosis. However, clinical usability and post-processing of 4D flow data is still an open issue. In this paper we present a new segmentation algorithm based on flow features at peak systole. This algorithm was applied to segment the aorta, the pulmonary artery and the heart ventricles

of 5 volunteers and 20 patients. Our methods clearly detected aorta abnormalities such as aorta aneurysms and stenosis, driven by and/or associated to BAV disease. 4D flow MRI is a well-established technique able to provide helpful information in the assessment of complex cardiovascular diseases and in the surgical planning stage. Improved algorithms for data segmentation are mandatory to speed-up 4D flow post-processing towards its clinical usability.

P. TKACHENKO, S. V. PEREVERZYEV, G. KRIUKOVA [1],
O. CHERTOV, M. ALEKSANDROVA [2]

Prediction of Nocturnal Hypoglycemia by an Aggregation of Previously Known Prediction Approaches

[1] *Johann Radon Institute for Computational and Applied Mathematics, Linz, Austria*
E-mail: pavlo.tkachenko@oeaw.ac.at
[2] *National Technical University of Ukraine "Kyiv Polytechnic Institute", Ukraine*

Nocturnal hypoglycemia (NH) is common in patients with insulin-treated diabetes. Despite the risk associated with NH, there are only few methods aiming at the prediction of such events based on intermittent blood glucose monitoring data and none has been validated for clinical use. Here we propose a method of combining several predictors into a new one that will perform at the level of the best involved one, or even outperform all individual candidates. Additionally, we present a strategy for training this combination in such a way that it will fulfill specific desired characteristics.

The idea is based on solving a low-dimensional system of linear equations, and thus does not require tough calculations. The proposed approach exhibits good performance in terms of sensitivity, specificity and predictive values. Moreover, it has the potential for everyday use by any patient who performs self-monitoring of blood glucose.

[1] G. Kriukova, O. Panasiuk, S.V. Pereverzyev, and P. Tkachenko. A linear functional strategy for regularized ranking. *Neural Networks* **1**, (2016), pp.26–35.

[2] P. Tkachenko, G. Kriukova, M. Aleksandrova, O. Chertov, E. Renard, S.V. Pereverzev. Prediction of Nocturnal Hypoglycemia by an Aggregation of Previously Known Prediction Approaches: Assessment of Usefulness for Clinical Application. Submitted to *Diabetes Technology & Therapeutics.*

N. VASYLYEVA [1]

Analytical and numerical study of the moving boundary problem with a time-fractional derivative in drug release devices

[1] *National Academy of Sciences of Ukraine, Sloviansk, Ukraine*
E-mail: nataliy_v@yahoo.com

We study anomalous diffusion version of the quasistationary Stefan problem (the fractional Hele-Shaw problem) in the multidimensional case $\Omega(t) \subset R^n$, $n \geq 2$. This free boundary problem in the case of zero surface tension of the moving boundary is a mathematical model of a solute drug release from a polymer matrix ($n = \overline{1,3}$). The relevant mathematical models of drug release from a polymeric matrix are powerful tools in studies of controlled-release drug system. Therefore, the investigations of fractional calculus in moving boundary problems would be of great interest to both theoretical and experimental studies in the future.

We prove the existence and uniqueness of the classical solution to this moving boundary problem locally in time. In the two-dimensional case we construct numerical solutions.

This is a joint work with Dr. L. Vynnytska (Oslo, Norway) and V. Overko (Sloviansk, Ukraine).

I. V. VERBYTSKYI [1], W. ERB [2]

Approximations of the Langevin function for a compact computation of the spectrum in Magnetic Particle Imaging

[1] *National Technical University of Ukraine Kyiv Polytechnic University, Kyiv, Ukraine*
E-mail: verbityskiy@bigmir.net
[2] *Institute of Mathematics, University of Lübeck, Germany*
E-mail: erb@math.uni-luebeck.de

Magnetic particle imaging (MPI) is a new tomographic imaging method which uses the nonlinear remagnetization behavior of magnetic nanoparticles to determine their local concentration in the scanner [1]. The particle distribution is reconstructed from the measured spectrum of the time-dependent magnetization. Developing and studying a mathematical model for the magnetization process allows the improvement of the reconstruction procedure. This procedure can be divided as follows:

- The magnetization of the nanoparticles modeled by a convolution of the magnetization curve with the concentration function.
- Calculation of the spectrum of the time-dependent magnetization.

The calculations of the convolution based on the Langevin magnetization curve and the subsequent computation of the spectrum can not represented directly with elementary functions. Therefore our goal is to approximate the Langevin function and the concentration signal appropriately in order to obtain a compact formula for the spectrum calculations. We propose the following two types of representations for the concentration signal and Langevin function:

- Approximations on basis of piecewise constant functions.
- Approximations on basis of expansions in Fourier series.

We estimate the accuracy of the calculations and analyse the advantages of these methods.

[1] T. Knopp, T.M. Buzug, Introduction into Magnetic Particle Imaging, Springer-Verlag, 2012.

S. VESENTINI [1], A. GAUTIERI [2]

Collagen Ageing form a Molecular Perspective

[1] *Department of Electronics, Information and Bioengineering, Politecnico di Milano, Milan, Italy*
E-mail: simone.vesentini@polimi.it
[2] *Department of Electronics, Information and Bioengineering, Politecnico di Milano, Milan, Italy*
E-mail: alfonso.gautieri@polimi.it

The non-enzymatic reaction of proteins with glucose (glycation) is a topic of rapidly growing importance in human health and medicine. There is increasing evidence that this reaction plays a central role in ageing and disease of connective tissues. Of particular interest are changes in type-I collagens, long-lived proteins that form the mechanical backbone of connective tissues in nearly every human organ. More daunting is to understand how these factors interact to cumulatively affect local repair of matrix damage, progression of tissue disease, or systemic health and longevity. Collagen crosslinks strongly influence the mechanical and biological function of connective tissue. While certain types of collagen crosslinks are essential to proper function, others can adversely affect tissue health. We attempted to distinguish crosslinks that promote tissue strength[1], stiffness, and resistance to failure, from the non-enzymatic crosslinks that are associated with progressive collagen glycation in ageing and diabetes [2]. Molecular modelling approach and X-ray diffraction analysis have been used to study the modification of collagenous tissues from the bottom-up. Concerning the last class of crosslinks, we propose possible therapeutic strategies to restore healthy.

[1] J.G. Snedeker, Muscles Ligaments Tendons J., 17, (2014), p. 303.
[2] A. Gautieri, Matrix Biol, 34, (2014), p. 89.

V. VOSKOBOINICK [1], A. REDAELLI [2], G. B. FIORE [2],
A. VOSKOBOINICK [1], A. ARTEMIEV [1], F. LUCHERINI [2]

Pressure fluctuations and vibrations beneath the bileaflet mitral valve for a diastolic cycle

[1] *Institute of Hydromechanics of NAS Ukraine, Kyiv, Ukraine*
[2] *Politecnico di Milano, Milan, Italy*
E-mail: vlad.vsk@gmail.com

The report presents the results of the experimental research of the jet flow noise and the vibrations of the open and the semi-closed prosthetic bileaflet mitral valve for the diastolic cycle. The studies were conducted in microlaboratory of the Polytechnic Institute of Milan. Hydrodynamic noise was measured by the miniature absolute pressure and pressure fluctuation sensors [1] inside the test bench with the prosthetic bileaflet mitral valve. Static pressure and pressure fluctuations of the central and the side jets that flowed from the open and the semi-closed mitral valve was studied for water flow discharge from 2.5l/min to 4l/min and pulse 60rpm. Vibrations measured on the bench cover and the atrium cover by the piezoceramic accelerometers [1, 2]. The changes integral and spectral characteristics of the field of pressure fluctuations and vibrations, depending on the flow regime and the condition of the mitral valve are detected. It is found that the spectral levels of the artificial bileaflet mitral valve in operating conditions of the semi-closed valve in the infrasound range of the flow noise to (4-6) times higher, than in the operating conditions of the open bileaflet mitral valve. For the open valve, the vibration levels more (2-3) times higher and more (3-4) times lower, than for the semi-closed valve in the frequency ranges (300-1500) Hz and (0,5-8) Hz, respectively. Experimental researches have shown that the valve flow noise and vibration measurements can be an effective diagnostic tool of the artificial bileaflet mitral valve operation.

[1] V. Voskoboinick, N. Kornev, J. Turnow *Flow Turbulence Combust.* **90(4)**, (2013), p. 709-722.

[2] V. A. Voskoboinick, V. T. Grinchenko, A. P. Makarenkov *Int. J. Fluid Mech.* **32(4)**, (2005), p. 488-510.

S. Ya. YANCHENKO [1]

Approximation of functions from Nikol'skii–Besov type classes of generalized mixed smoothness

[1] *Institute of Mathematics of NAS of Ukraine, Kyiv, Ukraine*
E-mail: yan.sergiy@gmail.com

In the present talk, we discuss the problem of the approximation of the classes $S^{\Omega}_{p,\theta}B(\mathbb{R}^d)$ of functions of many variables which are called Nikol'skii–Besov type classes of generalized mixed smoothness.

We obtain order estimates of approximation of the classes $S^{\Omega}_{p,\theta}B$ of functions of several variables defined on $\mathbb{R}^d$, in the $L_q(\mathbb{R}^d)$ norm, by entire functions of exponential type with supports of their Fourier transforms in sets that generated by the level surfaces of a function $\Omega(\boldsymbol{t})$.

A. YURCHENKO [1], T. KATRII [1], F. CONSOLO [2], O. SAVCHUK [1], G. FIORE [2], A. REDAELLI [2]

Comparative analysis of Platelet Activation in healthy donors and patients implanted with ventricular assist device through a chromogenic assay

[1] *Taras Shevchenko National University of Kyiv, Ukraine*
E-mail: alona.yurchenko@ukr.net
[2] *Politecnico di Milano, Italy*
E-mail: filippo.consolo@polimi.it

1. Introduction Beyond allowing conversion of fibrinogen to fibrin, it is known that thrombin also acts as platelets activator. Acetylated prothrombin, i.e., acetylated coagulation Factor II (Ac-FII), can be used to measure in vitro actual dynamics of platelets activation (PA) [1]. In this study, the Platelet Activation State assay (PAS assay) – a chromogenic-based assay, which makes use of Ac-FII – was used to quantity of the

PA level [2]. The aim was to compare the PA level of healthy donors vs patients implanted with ventricular assist device (VAD).

2. Methods Measurement of PA**.** Purified gel-filtered platelets (GFP) were separated from whole blood withdrawn from healthy donors and VAD recipients. To purify GFP, a two-steps protocol was employed consisting in: *i)* whole blood centrifugation (500g, 15min), followed by *ii)* plasma gel-column filtration in 200 mL of Sepharose 2B (Sigma-Aldrich, USA). For all the experiments, GFP were then diluted at a standard concentration of 20.000 pl/μl. Measurement of PA level was performed via the chromogenic PAS assay [3]. The final model system for the measurement of thrombin included: i) GFP at 5.000 pl/μl concentration; ii) Ac-FII 200 nM; iii) $CaCl_2$5 mM; iv) FXa 100 pM; v) HBS-BSA-PEG buffer pH 7.4 containing 20 mM HEPES, 130 mM NaCl, 0.1% BSA, PEG; vi) Chromozime 0.3 mM; vii) HBS-BSA-EDTA buffer containing 20 mM HEPES, 130 mM NaCl, 0,1% BSA and 0.2 M EDTA. Thrombin generation was quantified through spectrophotometric analysis over 8 min at an absorbance wavelength of 405 nm. PA was calculated as the slope of the linear regression of the absorbance *vs* time data points. PA of not-stimulated platelets (Blank) was normalized against the thrombin generation rate of fully activated platelets, obtained by exposing GFP to sonication (10 W, 10 sec). Statistical analysis of experimental data was carried out using Origin (OriginLab, USA).

3. Results and Discussion As expected, PAS assay revealed higher thrombin generation rate of patients implanted with VAD. In detail, not-stimulated GFP (Blanks) from the VAD recipient showed a normalized 10.7% PAS value, significantly higher with respect to the PAS value for the healthy donor, equal to 0.36%. Those data are consistent with the hyper-shear stimulation the VAD exerts on platelets, enhancing PA. On the other hand, the PA of VAD recipients, although higher than in healthy donors, was limited by the action of the anticoagulation drug therapy.

[1] Dougald M. Monroe, Maureane Hoffman, Harold R. Roberts. Platelets and Thrombin Generation. Arteriosclerosis, Thrombosis, and Vascular Biology. 2002.

[2] Jesty J, Bluestein D. Acetylated prothrombin as a substrate in the measurement of the procoagulant activity of platelets. Analytical Biochemistry. 1999.

[3] Valerio L, Consolo F, Bluestein D, Tran P, Slepian MJ, Redaelli A, Pappalardo F. Shear- mediated platelet activation in patients implanted with continuous flow LVADs: a preliminary studyutilizing the Platelet Activity State (PAS) assay. Conf Proc IEEE Eng.Med Biol Soc. 2015.

LIST OF PARTICIPANTS

- Antoniouk, Alexandra — antoniouk.a@gmail.com
- Bey, Christian — bey@math.uni-bremen.de
- Bilet, Viktoriia — viktoriiabilet@gmail.com
- Brinkmann, Ralf — brinkmann@mll.uni-luebeck.de
- Buj, Christian — buj@bmo.uni-luebeck.de
- Caimi, Alessandro — alessandro.caimi@polimi.it
- Cheredarchuk, Andrii — anri@biomed.kiev.ua, anri@ukrweb.net
- Chertov, Oleg — chertov@i.ua
- Derevianko, Nadiia — nadyaderevyanko@gmail.com
- Eller, Matthias — Matthias.Eller@georgetown.edu
- Erb, Wolfgang — erb@math.uni-luebeck.de
- Fernandez, Gabriela — gabriela.fernandez@polimi.it
- Filbir, Frank — filbir@helmholtz-muenchen.de
- Karabash, Illia — i.m.karabash@gmail.com
- Katrii, Tetiana — tetiana.katrii@gmail.com
- Keller, Karsten — keller@imath.uni-luebeck.de
- Kolomoitsev, Yurii — kolomus1@mail.ru
- Kriukova, Galyna — galyna.kriukova@oeaw.ac.at
- Kudybyn, Ihor — igorkudubun@ukr.net
- Kyselova, Anna — a.g.kyselova@gmail.com
- Langemann, Dirk — d.langemann@tu-bs.de
- Lomako, Tetiana — tlomako@yandex.ru
- Mel'nyk, Taras — melnyk@imath.kiev.ua

- Münter, Michael muenter@mll.uni-luebeck.de
- Myronyuk, Vitalii VetalMyronjuk@ukr.net
- Naumova, Valeriya valeriya@simula.no
- Nesteruk, Igor inesteruk@yahoo.com
- Overko, Vitalii vitaliioverko@gmail.com
- Pereverzyev, Sergei sergei.pereverzyev@ricam.oeaw.ac.at
- Petrov, Evgeniy eugeniy.petrov@gmail.com
- Piek, Albert piek@math.uni-luebeck.de
- Pilipenko, Andrey apilip@imath.kiev.ua
- Prestin, Jürgen prestin@math.uni-luebeck.de
- Redaelli, Alberto alberto.redaelli@polimi.it
- Rößler, Andreas roessler@math.uni-luebeck.de
- Rudnytskyi, Oleksandr rudnitskii@mail.ru
- Selmi, Matteo matteo.selmi@mail.polimi.it
- Semenov, Vasyl mlev@bk.ru
- Semenova, Evgeniya semenovaevgen@gmail.com
- Shydlich, Andrii shidlich@gmail.com
- Siryk, Sergii accandar@gmail.com
- Stasyuk, Serhii stas.serg.a@gmail.com
- Sulema, Yevgeniya sulema@pzks.fpm.kpi.ua
- Tereshchenko, Igor tereshchenko.igor@gmail.com
- Tereshchenko, Lidiia lida_tereschenko@mail.ru
- Tkachenko, Pavlo pavlo.tkachenko@ricam.oeaw.ac.at
- Vasylyeva, Nataliya nataliy_v@yahoo.com

- Verbytskyi, Ievgen verbitskiy@bigmir.net
- Vesentini, Simone simone.vesentini@polimi.it
- Voskoboinick, Alexander alexandr.vsk@gmail.com
- Voskoboinick, Vladimir vlad.vsk@gmail.com
- Yanchenko, Sergiy Yan.Sergiy@gmail.com

Program

Monday, March 07

16.15 - 16.30 **Conference opening**

Chair: Jürgen Prestin

16.30 - 17.00 **Sergei Pereverzyev** p. 20
Multi-penalty regularization in reconstruction of causality network

17.00 - 17.20 **Pavlo Tkachenko** p. 34
Prediction of nocturnal hypoglycemia by an aggregation of previously known prediction approaches

17.20 - 17.40 **Galyna Kriukova** p. 12
Nyström type subsampling analyzed as a regularized projection

17.40 - 18.00 **Viktoriia Bilet** p. 2
Boundedness of Lebesgue Constants and Porosity

Tuesday, March 08

Chair: Sergei Pereverzyev

09.00 - 09.30 **Frank Filbir** p. 8
Mathematics of photoacoustic tomography

09.30 - 09.50 **Michael Münter** p. 16
Resolution and contrast of an optical full-field holographic system for fast non-contact Photoacoustic Tomography

09.50 - 10.10 **Christian Buj** p. 3
Speckle-based off-axis holographic detection for non-contact Photoacoustic Tomography

10.10 - 10.30 **Yevgeniya Sulema** p. 31
Brain tissue image adjustment method

10.30 - 11.00 **Coffee break**

Chair: Karsten Keller

11.00 - 11.30 **Wolfgang Erb** p. 6
Multivariate interpolation on Lissajous-Chebyshev nodes and applications in Magnetic Particle Imaging

11.30 - 11.50 **Ievgen Verbytskyi** p. 36
Approximations of the Langevin function for a compact computation of the spectrum in Magnetic Particle Imaging

11.50 - 12.10 **Tetiana Lomako** p. 14
On growth of Lebesgue constants for convex polyhedra

12.10 - 12.30 **Yurii Kolomoitsev** p. 11
New inequalities for moduli of smoothness in L_p, $0 < p < 1$

12.30 - 14.30 **Lunch**

Chair: Dirk Langemann

14.30 - 15.00 **Illia Karabash** p. 8
Concentration inequalities for random Fourier series and related questions

15.00 - 15.20 **Vasyl Semenov** p. 27
Method of Blind Source Separation for QPSK signals

15.20 - 15.40 **Nadiia Derevianko** p. 5
One orthogonal trigonometric Schauder basis and local Besov spaces

15.40 - 16.00 **Vitalii Myronyuk** p. 17
Orthogonal trigonometric Schauder basis in the space $\boldsymbol{C(\mathbb{T}^2)}$

16.00 - 16.30 **Coffee break**

Chair: Nataliya Vasylyeva

16.30 - 17.00 **Andreas Rößler** p. 24
Strong SRK methods for SDAEs of index 1 with scalar noise

17.00 - 17.20 **Andrii Shydlich** p. 29
Nonlinear approximation of the classes $\mathcal{F}^{\psi}_{q,r}$ *of functions of several variables in* L_p

17.20 - 17.40 **Serhii Stasyuk** p. 31
Nonlinear trigonometric approximation for functions with generalized mixed smoothness

17.40 - 18.00 **Sergiy Yanchenko** p. 39
Approximation of functions from Nikol'skii–Besov type classes of generalized mixed smoothness

Wednesday, March 09

Chair: Igor Nesteruk

09.00 - 09.30 **Alberto Redaelli** p. 23
In vitro and in silico evaluation of the Mitraclip® system

09.30 - 09.50 **Simone Vesentini** p. 37
Collagen Ageing form a Molecular Perspective

09.50 - 10.10 **Matteo Selmi** p. 26
Aortic Root Biomechanics Following David and Sleeve Procedures: A Finite Element Analysis

10.10 - 10.30 **Alessandro Caimi** p. 4
Finite Element Simulation of a Transcatheter Aortic Valve Implantation

10.30 - 11.00 **Coffee break**

Chair: Alberto Redaelli

11.00 - 11.30 **Igor Nesteruk** p. 18
Cooperation between Politecnico di Milano and the Institute of Hydromechanics NASU in the EUMLS Project Framework

11.30 - 11.50 **Lidiia Tereshchenko** p. 33
Application of the hydrodynamics - based algorithm for segmentation of aorta, pulmonary artery, left and right ventricles with the use of 4D MRI data

11.50 - 12.10 **Igor Tereshchenko** p. 32
Construction of spatial model of cervical vessels based on MRI images

12.10 - 12.30 **Oleksandr Rudnytskyi** p. 25
3D segmentation and denoising of anatomical structures via fractal and morphological filtering

12.30 - 14.30 **Lunch**

14.30 **Excursion to Schwerin**

Thursday, March 10

Chair: Taras Mel'nyk

09.00 - 09.30 **Karsten Keller** p. 11
Dynamical Structure, Entropy and Data: Approaches and Perspectives

09.30 - 09.50 **Andrey Pilipenko** p. 22
On a selection problem for small noise perturbation of unstable dynamical systems

09.50 - 10.10 **Valeriya Naumova** p. 17
Conditions on optimal support recovery in unmixing problems by multi-penalty regularization

10.10 - 10.30 **Albert Piek** p. 22
A distance measure for ordinal patterns

10.30 - 11.00 **Coffee break**

Chair: Alexandra Antoniouk

11.00 - 11.30 **Taras Mel'nyk** p. 15
Asymptotic approximations of solutions to boundary-value problems in thin aneurysm-type domains

11.30 - 11.50 **Nataliya Vasylyeva** p. 35
Analytical and numerical study of the moving boundary problem with a time-fractional derivative in drug release devices

11.50 - 12.10 **Evgeniya Semenova** p. 28
Informational efforts for solving severely ill-posed problems

12.10 - 12.30 **Evgeniy Petrov** p. 21
Rigidity of finite ultrametric spaces

12.30 - 14.30 **Lunch**

Chair: Oleg Chertov

14.30 - 15.00 **Vladimir Voskoboinick** p. 38
Pressure fluctuations and vibrations beneath the bileaflet mitral valve for a diastolic cycle

15.00 - 15.20 **Vitalii Overko** p. 19
Features of the blood flow in the curved vessels and the arterial bifurcation

15.20 - 15.40 **Ihor Kudybyn** p. 13
The comparison of the efficiency of human motion (running, swimming, skiing, skating, cycling and rowing)

15.40 - 16.00 **Sergii Siryk** p. 30
Weight functions and computational schemes of the Petrov-Galerkin FEM for convection-diffusion problems

16.00 - 16.30 **Coffee break**

Chair: Valeriya Naumova

16.30 - 17.00 **Anna Kyselova** p. 13
Context-Aware Approach for Management System

17.00 - 17.20 **Tetiana Katrii** p. 9
Characterization of acetylation of coagulation Factor II through a chromogenic assay

17.20 - 17.40 **Gabriela Fernandez** p. 7
Modeling of material and energy flows in the Metropolitan City of Milan, Italy using urban metabolism approaches