TUESDAY, NOVEMBER 7, 2017

Practical aspects of the d-guarantee

Simushkin S., Volodin I.

Kazan Federal University, Kazan, Russia
smshkn@gmail.com, igornvolodin@gmail.com

The concept of guaranteeing the statistical inference, based on the magnitude of average losses among the experiments that resulted in the adoption of the same decision, originates from the labors of mathematicians of the Kazan University of the end of the last century. This approach to the analysis of the properties of statistical procedures was called d-posterior. The development of the concept led to the formulation and solution of a number of practically important and interesting tasks. In particular, for the problem of distinguishing two arbitrary parametric hypotheses, optimal statistical rules were found that minimize the average losses and the average required volume of observations. It is shown that, as in the classical approach, when distinguishing two hypotheses, an analogue of the p-value can be used. A universal sequential guarantee procedure was proposed and its optimal properties were established for some statistical problems. A method is given for constructing confidence statements that guarantee a natural requirement for the probability of finding the desired parameter in the region indicated in this statement. The problem of constructing statistical estimates minimizing the general function of d-a posteriori risk was solved. In this regard, the notion of unbiasedness was revised. Among the latest practical applications of the d-a posteriori approach, one can single out a very popular trend in genetics related to the need for multiple testing (FDR, pFDR, etc.). Applying the methods of the d-a posteriori approach to this topic allows us to control not only the average share of false discoveries (the FDR analog), but also the average share of erroneous null hypothesis (FNR) assumptions, and also set and solve problems on distinguishing more than two hypotheses (for example, gene isolation with unchanged, increased and decreased activity).

Poisson limit theorem for a number of given value cells from a pointed set of cells

Chuprunov A., Alhouzani M.

Kazan Federal University, Kazan, Russia
achuprunov@mail.ru

We consider a random variable that is a number of cells from first K cells which contain r particles in a homogeneous allocation scheme of distinguishing particles. For $r \geq 3$ we prove the convergence of this random variable to a Poisson random variable. A description of this Poissonian limit random variable was obtained.

Aviation Industry Stochastic Model Based on Big Data Concept

Valeev S., Kondratyeva N.

Ufa State Aviation Technical University, Ufa, Russia
vss2000@mail.ru, knv24@mail.ru

Modern aviation industry is a complex large scale system that includes designing, testing,production, operation, maintains services etc. Thus, it seems reasonable to provide information logistical support throughout the life cycle of single processes in this area. On the other hand, it allows building stochastic models to manage aviation industry in real-time mode under uncertainties and risks conditions. It is possible to provide using Big Data concept. Scope of Big Data technologies is very wide. In particular, it covers a complex of organizational and technical systems, such as aircraft systems, aircraft building enterprises, etc. Data on the functioning of these systems is characterized by high volume, heterogeneous structure and a high frequency of updating.

Lower bounds for the expected sample size for classical and d-posterior statistical problem

Kareev I., Volodin I.

Kazan Federal University, Kazan, Russia
kareevia@gmail.com, igornvolodin@gmail.com

In this report, the problem of construction of lower bounds for the expected sample size of statistical inference procedures is considered. The general methodology for construction of the lower bounds and review of the main results for classical statistical problems are presented, among with new early results of the adoption of the technique to the d-posterior approach. Namely, the hypothesis testing problem is considered.

Risk function and optimality of statistical procedures for network structures identification

Koldanov P.

NRU Higher School of Economics, Nijni Novgorod, Russia
pkoldanov@hse.ru

A class of network structures identification problem by sample of finite size is considered. The concepts of random variables network and network model which is complete weighted graph are introduced. Two types of network structures are investigated: the network structures with arbitrary number of elements and the network structures with fixed number of elements of network model. The problem of network structures identification as multiple decision problem is considered. Risk function of statistical procedures of network structures identification can be represented as linear combination of expected numbers of incorrectly included elements and incorrectly non included elements. The sufficient conditions of optimality for statistical procedures for network structures identification with arbitrary number of elements are given. Concept of statistical uncertainty of statistical procedures for network structures identification is introduced.

D-posterior approach in regression analysis

Zaikin A.

Kazan Federal University, Kazan, Russia
kaskrin@gmail.com

In this report we presented an attempt to use d-posterior approach in a couple of regression problems. First, we study simple linear regression with Gaussian white noise. For the quadratic loss function we present estimates with uniformly minimal d-risks. Second, we study regression for binary dependent variable. In that case d-posterior approach is used for logit regression model, and we develop a classification rule, which minimizes maximum of two d-risks. The resulting decision rules are compared to usual Bayesian decisions.

Neuromathematics is an effective tool for forecasting social development of Russian regions

Dziuba E., Gubarev R.

Plekhanov Russian University of Economics, Moscow, Russia
intellectrus@yandex.ru, gubarev.roma@yandex.ru

Social development of Russian regions is simulated on the basis of neuromathematics. It is established empirically that the change in the social development of the Russian Federation constituent entities is described accurately by the Bayesian dynamic assembly of five neural networks of various configurations. Predictions are made for social development of the leading regions of the Russian Federation, the Volga Federal District and the Republic of Bashkortostan, in the medium term. With the purpose of the backlog of the Republic from the leading regions of the country the directions of developing its innovative activities are specified.

Two-sided confidence intervals for the d-posterior approach

Simushkin S.

Kazan Federal University, Kazan, Russia
smshkn@gmail.com

At the end of the last century, the author (together with I.N. Volodin) proposed a method for constructing trust families constructed in such a way that a natural connection was preserved with the possibility of checking the corresponding hypothesis with restrictions on the d-a posterior probability of a first-kind error. Unfortunately, the implementation of this method in the construction of bilateral confidence statements is difficult to perceive, since it is impossible in the form of a description of two confidence boundaries. In this message, some ways of correcting this situation are considered. New asymptotically trustworthy families are proposed, as well as another approach to the definition of confidence.

Improved nonparametric estimation of the drift in diffusion processes

Perelevskiy S.

Tomsk State University, Tomsk, Russia
slavaperelevskiy@mail.ru

In this paper, we consider the robust adaptive non parametric estimation problem for the drift coefficient in diffusion processes. An adaptive model selection procedure, based on the improved weighted least square estimates, is proposed. Sharp oracle inequalities for the robust risk have been obtained.

Sequential d-guaranteed estimate of the mean value for the normal distribution

Salimov R.

Kazan Federal University, Kazan, Russia
rustem.salimov@gmail.com

The problem of an estimation of the mean value of the normal distribution with a prior information that this parameter is positive and very small is considered. The prior information is implemented in terms of the exponential prior distribution. The estimation procedures are presented for two cases: fixed sample size and sequential estimation that guarantee the given constraints on the precision and the d-risk of the estimator.

On the estimation of the rate of convergence in the multidimensional limit theorem for sums of the functions of weakly dependent random variables

Gabbasov F., Dubrovin V., Fadeeva M.

Kazan State University of Architecture and Engineering, Kazan, Russia
gabbasov@kgasu.ru

In this article, we obtain a more accurate estimation of the convergence rate in a the multidimensional central limit theorem for sums of functions of sequences of random variables satisfying the strong mixing condition.

WEDNESDAY, NOVEMBER 8, 2017

Completely positive perturbations of quantum dynamical semigroups

Holevo A.

Steklov Mathematical Institute of the Russian Academy of Sciences, Moscow, Russia
holevo@mi.ras.ru

We describe an approach to strongly continuous quantum dynamical semigroups via completely positive perturbations of their (in general, unbounded) generators. The semigroup is standard if its generator is "of Lindblad's type", i.e. it is obtained by a completely positive perturbation of a "no-event" generator. Then we consider two cases of dynamical semigroups obtained by singular rank-one perturbations of a standard generator. First, we describe an example which gives a positive answer to a conjecture of Arveson concerning possible triviality of the domain algebra. Second, we consider an improved and simplified construction of a nonstandard dynamical semigroup outlined previously in our short communication. This gives answer to an old question on existence of dynamical semigroups with non-Linbladian generators.

Multi-normed spaces, based on non-discrete measures, and their tensor products

Helemskii A.

Moscow State University, Moscow, Russia
helemskii@rambler.ru

It was A. Lambert who discovered a new type of structures, situated, in a sense, between normed spaces and (abstract) operator spaces. His definition was based on the notion of amplification a normed space by means of spaces ℓ_2^n . Afterwards several mathematicians investigated more general structure, 'p-multi-normed space', introduced with the help of spaces $\ell_p^n; 1 \leq p \leq \infty$. In the present paper we pass from ℓ_p to $L_p(X, \mu)$ with an arbitrary measure. This happened to be possible in the frame-work of the non-coordinate ('index-free') approach to the notion of amplification, equivalent in the case of a discrete counting measure to the approach in mentioned articles.

Two categories arise. One consists of amplifications by means of an arbitrary normed space, and another one consists p-convex amplifications by means of $L_p(X, \mu)$. Each of them has its own tensor product of its objects whose existence is proved by a respective explicit construction. As a final result, we show that the 'p-convex' tensor product has especially transparent form for the so-called minimal L_p-amplifications of L_q-spaces, where q is the conjugate of p. Namely, tensoring $L_q(Y, \nu)$ and $L_q(Z, \lambda)$, we get $L_q(Y \times Z, \nu \times \lambda)$.

Symmetry and the Shirali-Ford theorem

Fragoulopoulou M.

National and Kapodistrian University of Athens, Greece
fragoulop@math.uoa.gr

Symmetry and hermiticity are pure algebraic concepts that Kaplansky conjectured, in 1947, that coincide. Symmetry always implies hermiticity. Shirali and Ford proved, in 1970, that the converse is also true in the context of Banach *–algebras. The conjecture is not true, in general, and this was shown by Wichmann, in 1974. In this talk, we shall give a short, non–technical, but conceptual proof of the Shirali–Ford theorem, based on Pták's celebrated theory of hermitian algebras.

Chaotic coverings of solenoids and automorphisms of semigroup C^*-algebras

Gumerov R.

Kazan Federal University, Kazan, Russia
renat.gumerov@kpfu.ru

Solenoids arise in various branches of mathematics and physics. They are closely related to semigroup C^*-algebras. The report deals with dynamical properties of finite-sheeted covering mappings of P-adic solenoids. Also, necessary and sufficient conditions for endomorphisms of semigroup C^*-algebras to be automorphisms are given.

Probability convergence of measurable operators arithmetical means

Bikchentaev A.

Kazan Federal University, Kazan, Russia
Airat.Bikchentaev@kpfu.ru

Let $\mathcal{M}$ be a von Neumann algebra of operators on a Hilbert space $\mathcal{H}$ and τ be a faithful normal semifinite trace on$\mathcal{M}$. We prove an analog of M.G. Kreĭn Theorem (for $\mathcal{M} = \mathcal{B}(\mathcal{H})$ and $\tau = \mathrm{tr}$, Theorem 11.4, Ch. V, "I.C. Gohberg, M.G. Kreĭn, Introduction to the theory of linear nonselfadjoint operators", Trans. Mathem. Monographs, v. 18, Amer. Math. Soc., Providence, R.I., 1969) for τ-measurable operators.

Shift-invariant measures on infinite-dimensional spaces, integrable functions and random walks

Zavadsky D.

Moscow Institute of Physics and Technology, Moscow, Russia
Dmitriyx2013@yandex.ru

We study operator semigroups on spaces of square integrable functions. We construct a collection of one-parameter strongly continuous operator semigroups. As a result of averaging we obtain a new one-parameter operator set, which is a strongly continuous operator semigroup.

Levy Laplacians and Annihilation Process

Volkov B.

Steklov Mathematical Institute of the Russian Academy of Sciences, Moscow, Russia
borisvolkov1986@gmail.com

One can consider two different Levy Laplacians in the theory of Sobolev-Schwartz distributions over the Gaussian measure (the Hida calculus). For the first of them the representation $\int_0^1 a_t^2(dt^2)$, where a_t is the annihilation process, is known. In the present paper we show that the second Lévy Laplacian can be represented as $\int_0^1 \dot{a}_t^2(dt^2)$, where $\dot{a}_t$ is the derivative of the annihilation process. The interest in the last Laplacian is due to its connection to the gauge fields.

On the existence of anticliques for non-commutative operator graphs

Amosov G.

Steklov Mathematical Institute of the Russian Academy of Sciences, Moscow, Russia
gramos@mi.ras.ru

A linear space V consisting of linear operators in a Hilbert space H is said to be a non-commutative operator graph if the identity operator $I \in V$ and $A \in V$ implies that $A^* \in V$. We discuss the general properties of non-commutative operator graphs. A special attention is paid to the graphs generated by the resolution of the identity being covariant with respect to the unitary representation of a locally compact group.

Quantum Information and Quantum Hashing

Ablaev F., Vasiliev A.

Kazan Federal University, Kazan, Russia
farid.ablayev@kpfu.ru, alexander.ksu@gmail.com

Recently we have proposed a generalization of the quantum hashing technique based on the notion of small-bias sets. These sets have proved useful in different areas of computer science, and their properties give an optimal construction for succinct quantum presentation of elements of any finite Abelian group, which can be used in various computational and cryptographic scenarios.

In this paper we investigate the pre-image resistance of this function and show that it reveals only O(1) bits of information about the input. Additionally, we use several heuristic algorithms to explicitly construct small-bias sets of a certain size, thus supporting the collision resistance of our hash function.

Nonunitary maps in the estimation of qubit channel capacities

Filippov S.

Institute of Physics and Technology of the Russian Academy of Sciences, Moscow, Russia
sergey.filippov@phystech.edu

Classical capacity of unital qubit channels is well known, whereas that of non-unital qubit is not. We find lower and upper bounds on classical capacity of non-unital qubit channels by using a recently developed decomposition technique relating non-unital and unital qubit channels.

Machine learning approach to open quantum systems

Luchnikov I.

Moscow Institute of Physics and Technologies, Moscow, Russia
luchnikovilya@gmail.com

Exact description of dynamics for arbitrary open quantum system is the very challenging task. Usually quantum reservoir is a many-body quantum system. It is difficult to describe numerically or analytically. We propose to consider the approximation of a complex many-body reservoir with a low-dimensional reservoir.

We will present an estimate of the error for such approximation. The estimate is obtained using the tensor network approach. Possible methods for predicting the dynamics of open quantum systems using this ansatz will be discussed. We will also discuss the machine learning approach based on this ansatz for predicting the dynamics of a quantum system in a real experiment. We will consider other possible ansatzes for a quantum reservoir such as neural networks and graphical models. A similar approach is used in the other paper to describe quantum states. It will be shown that the problem of sound recognition in machine learning and the problem of predicting the dynamics of an open quantum system have much in common.

Two coupled quantum oscillators interacting with two heat baths

Dudinets I.

Moscow Institute of Physics and Technologies, Moscow, Russia
dudinecIvanVas@yandex.ru

We study a system of two coupled oscillators each of the oscillator linearly interacts with its own heat bath consisting of a set of independent harmonic oscillators. The initial state of the oscillator is taken to be coherent while the oscillators of heat baths are in thermal states. We analyze the time-dependent state of the two oscillators which is a two-mode Gaussian state. By making use of Simon's separability criterion we show that this state is separable for all times. We consider the equilibrium state of the two coupled oscillators in detail and calculate its Wigner function.

THURSDAY, NOVEMBER 9, 2017

Estimating quantum entanglement in a class of N-qudit states

Abe S.

Mie University, Mie, Japan
suabe@sf6.so-net.ne.jp

The logarithmic derivative (or, quantum score) of a density matrix in the quantum Cramér-Rao inequality is discussed. Then, the problem of estimating the parameters in a class of the Werner-type N-qudit states is studied. The largest value of the lower bound to the error of estimate by the quantum Fisher information is found to coincide with the separability point only in the case of two qubits. It is shown that, on the other hand, such largest values give rise to the universal fidelity that is independently of the system size.

Statistical Applications of the Dependent Bootstrap Procedure

Volodin A.

University of Regina, Regina, Canada
andrei.volodin@uregina.ca

The validity of bootstrap estimators has received considerable attention in recent years due to a growing demand for the procedure, both theoretically and practically. The sample mean is fundamental for parameter estimation in statistics. Therefore, most of the recent literature on the bootstrap is devoted to statistics of this type. In this talk, an informal introduction to the dependent bootstrap procedure. Statistical applications of this notion lead to consideration of some exiting dependent structures that I would like to introduce and discuss. Note that the dependent bootstrap procedure is proposed as a procedure to reduce variation of estimators and to obtain better confidence intervals. This is a new area of a research and there are many interesting problems for Master or PhD students to work on.

Lebesgue and Feynman generalized measures and their applications

Smolyanov O.

Moscow State University, Moscow, Russia
smolyanov@yandex.ru

Lebesgue and Feynman generalized measures on a topological vector space E are defined to be linear (continuous) functionals on proper spaces of functions on E, which are similar to the Sobolev-Schwartz spaces of test functions, the Lebesgue generalized measure being translation invariant. The value which the generalized measure ν takes on a function f from its domain is called the integral of f with respect to ν. If $dimE = \infty$ then the Lebesgue generalized measure is not generated by any usual σ-additive Borel measure on E (due to a theorem of A.Weil). The important example of such integrals is the Feynman functional (path) integral. Using the Feynman path integrals one can represent the solutions of Cauchy problems for some evolutionary differential equations and also for some other objects related to those equations. The corresponding formulas are called the Feynman-Kac formulas. There are also some other

applications of the Feynman functional integrals, in particular to investigating the so called quantum anomalies. The approach to quantum anomalies, which uses the Feynman path integrals, permits a simple description of the origin of quantum anomalies in terms of differential properties of the Lebesgue and Feynman generalized measures, or, equivalently, of the Feynman path integrals. In the talk a criteria of the existence of the quantum anomalies will be formulated. Some results of the talk are obtained together with John Gough, James Montaldi and Tudor Ratiu.

Independization of Random Operator-function and the Law of Large Numbers for Maps

Sakbaev V.

Moscow Institute of Physics and Technologies, Dolgoprudny, Russia
fumi2003@mail.ru

The notion of random semigroup of bounded linear operators in Hilbert space will be investigated. The semigroup property and the property of independence of the increments of random operator-valued function are studied.

The Feynman-Chernoff iteration of random operator valued function will be intoduced as the sequence of compositions of independent identically distributed random operator valued functions. The convergence of the mean values of Feynman-Chernoff iteration of random semigroup to some averaged semigroup is obtained by means of Chernoff theorem. The estimates of the deviation of compositions of independent identically distributed random semigroup from its mean value is obtained as the law of large numbers for the sequence of compositions of independent random semigroup. The relationship between the semigroup properties of mean values of random operator valued function and the property of independence of increments of random operator valued function is studied. The property of asymptoticaly independence of Feynman-Chernoff iteration of the random semigroup is investigated. The independization of the random operator valued function is defined as the map of this random function into the sequence of random operator valued functions which has asymptoticaly independent inncrement. The examples of independization of random operator valued function are given.

Quantum spectral symmetries

Turilova E.

Kazan Federal University, Kazan, Russia
Ekaterina.Turilova@kpfu.ru

We bring new results on preservers of the spectral order for unbounded positive operators affiliated to a von Neumann algebra. We show that unlike factor of Type I not all spectral automorphisms are compositions of function calculus with a natural extension of projection lattice automorphism. However, we characterize such canonical automorphisms as those who preserves multiples of projections.

Commutators of projectors and projective geometry

Zhdanovskiy I.

Moscow Institute of Physics and Technologies, Moscow, Russia
ijdanov@mail.ru

Consider k linear operators acting in vector space of dimension n. Recall that wild problem in linear algebra is a classification of k operators up to simultaneous similarity. Two linear operators are defined by eigenspaces and eigenvalues. For simplicity, assume that each operator have different eigenvalues. In this case eigenspaces of operator define configuration of n points in projective space. k operators define configuration of k^n points in projective space. If k operators have common eigenspace then this configuration is degenerated. We will call this degeneration by linear-algebraic. There is another type of degeneration of configuration, so called geometric degeneration. In my talk, I will tell about geometric degenerations. I will formulate these degenerations in terms of operators. This talk is based on joint work with Kocherova Anna.

Measurements and operator convex functions

Tikhonov O.

Kazan Federal University, Kazan, Russia
Oleg.Tikhonov@kpfu.ru

Let $B(H)$ be the algebra of bounded operators in a Hilbert space H, $(\Omega, \mathcal{A})$ be a measurable space, and $\mathbb{X}$ be a measurement, i. e., a $B(H)^+$-valued measure on $\mathcal{A}$ with $\mathbb{X}(\Omega) = 1$. For a Borel function $f : \Omega \to [0, +\infty]$, we consider $\int\limits_\Omega g\, d\mathbb{X}$ as the element of extended positive part of $B(H)$. Let $f : [0, +\infty) \to [0, +\infty)$ be a continuous operator convex function, $f(+\infty) = \lim\limits_{x\to+\infty} f(x) = +\infty$.

We prove that $\int\limits_\Omega f \circ g\, d\mathbb{X} \geq f\big(\int\limits_\Omega g\, d\mathbb{X}\big)$.

Ultraproducts of von Neuman algebras and ergodicity

Haliullin S.

Kazan Federal University, Kazan, Russia
Samig.Haliullin@kpfu.ru

We introduce the concept of ergodic action with respect to a normal state of group on an Abelian von Neumann algebra and its properties are studied. Also ultraproduct of this actions is considered. Here we apply the A. Ocneanu ultraproduct.

Commutators and representation theory

Kocherova A.

Moscow Institute of Physics and Technologies, Dolgoprudny, Russia
akocherova@yandex.ru

Classification of mutually unbiased bases (MUB) is a famous problem in Quantum information theory. Complete classification is known only in the case of dimension less than 6. These was a conjecture of S.Popa that there exists finite set of MUBs in prime dimension. Petrescu constructed one-dimensional family of MUBs in dimension 7. In my talk, I will present an algebraic method of studying Petrescu family.

On a derivations in group algebras

Arutyunov A.

Moscow Institute of Physics and Technologies, Moscow, Russia
andronick.arutyunov@gmail.com

The talk is based on joint results with Professor A.S. Mischchenko and A.I. Schtern.

We will talk about interesting question which was researched by such mathematician as B. Johnson and V. Losert. The question is the description of Lea algebra of derivations on a (typically infinite noncommutative) group algebra.

A linear map $d : C[G] \to C[G]$ is called the derivation if it holds the condition $d(uv) = d(u)v + ud(v)$. This question is equivalent to describing the Hochhschold homology. More precisely we are going to descript an algebra of derivations with an accuracy to inner derivations. The derivation is called inner if it is given by formula $x \to [a, x]$.

We will set out the categorical view on this problem. The idea is to consider a gruppoid Γ associated to the conjugacy action of the group. Derivations can be interpreted as a chatacters on the gruppoid (complex-valued functions on morphisms, which hold the conditon $\chi(\psi \circ \phi) = \chi(\psi) + \chi(\phi)$ for pairs of morphisms ϕ, ψ such that a composition $\psi \circ \phi$ is well defined).

This idea makes able to get a description of derivations in combinatorial terms of generators and relations of a group G. We will obtain conditions for charachters to generate a derivation. So we will look for some examples. We well describe derivations ia an abelian free group and a group algebra of the Heisenberg group.

Weighted goodness-of-fit Cramer-von Mises and the Anderson-Darling tests

Martynov G.

Institute for Information Transmission Problems, Russian Academy of Sciences, Moscow, Russia
magevl@gmail.com

The Anderson-Darling test is a specific case of the weighted omega square tests. Usage of the other weighted tests can expand utility of goodness of fit tests in practical situations. New theory of the Anderson-Darling test and new analytical results for the tests with other weight functions are developed. The tables of the limit distributions are presented.

A low-rank approximation of tensors

Sharafutdinov A., Gumerov R.

Kazan Federal University, Kazan, Russia
shash1996@mail.ru

We consider tensor products of finite-dimensional vector spaces. A tensor is an element of such a space.

The rank is a numerical characteristic of a tensor, and may be considered as a measure of its complexity. By definition, the rank is the minimum number of summands in representations of a given tensor as sums of elementary tensors. For example, the joint probability distribution of three discrete independent random varibles taking finite numbers of values is a tensor of rank 1.

The report is concerned with properties of the rank, in particular, with the low-rank approximation problem for higher order tensors. As is well known, that problem is of great interest in the statistical analysis of multiway data.

FRIDAY, NOVEMBER 10, 2017

Manifold learning in statistical tasks

Bernstein A.

Skolkovo Institute of Science and Technology, Moscow, Russia
a.bernstein@skoltech.ru

Many Data Analysis tasks deal with high-dimensional data, and curse of dimensionality is an obstacle to the use of many methods for their solutions. In many applications, real-world data occupy only a very small part of high-dimensional observation space whose intrinsic dimension is essentially lower than dimension of the space. Popular model for such data is Manifold one in accordance with which data lie on or near an unknown low-dimensional Data manifold (DM) embedded in an ambient high-dimensional space. Data analysis tasks studied under this assumption are referred to as the manifold learning ones whose general goal is discovering a low-dimensional structure of high-dimensional manifold valued data from given dataset.If dataset points are sampled according to an unknown probability measure on the DM, we face with statistical problems about manifold valued data.

The speech gives short review of statistical problems regarding high-dimensional manifold valued data and their solutions.

Predictive Modeling based on data in Industrial Engineering

Burnaev E.

Skolkovo Institute of Science and Technology, Moscow, Russia
e.burnaev@skoltech.ru.

Predictive Analytics and Modeling is the identification of likely outcomes or possible predictions in the future by using statistical methods and machine learning algorithms to conduct analysis based on historical data. The objective is to not merely identify trends based on past information, but rather to assess systematically what is likely to happen. The most common application of predictive modeling in industrial engineering is in connection to black-box optimization. Indeed, on the one hand, design optimization plays a central role in the industrial design process; on the other hand, a single optimization step typically requires the optimizer to create or refresh a model of the response function whose optimum is sought, to be able to come up with a reasonable next design candidate. The predictive models used in optimization range from simple local linear regression employed in the basic gradient-based optimization to complex global models employed in the so-called Surrogate-Based Optimization (SBO). Aside from optimization, predictive modeling is used to perform model-based predictive control and predictive maintenance of complex technical systems.

In this presentation we are going to provide an overview of typical scenarios of predictive modeling applications in industrial engineering, as well as corresponding use cases, highlight main issues on how to construct and apply predictive models, describe both state-of-the-art techniques and a few novel predictive modeling algorithms along with their theoretical properties, demonstrate the efficiency of the predictive modeling methodology on several industrial engineering problems.

Smooth Vector Fields Estimation on Manifolds by Optimization on Stiefel Group

Abramov E.

Higher School of Economics, Moscow, Russia
petzchner@gmail.com

The real data usually has a high dimensionality. However, the "real" data obtained from real sources, due to the presence of various dependencies between data points and limitations on their possible values, take as the rule a small part of the high-dimensional space of observations. The most common model for describing such data is the hypothesis that data lie on or near a manifold of a smaller dimension. This assumption is called the Manifold Hypothesis, inference and calculations under it are called Manifold Learning.

Grassmann Stiefel Eigenmaps is one of Manifold Learning algorithms and one of its subproblem is considered: smooth vector fields estimation by optimization on the Stiefel group. The two step algorithm are introduced to solve the problem and numerical experiments with artificial data are performed.

Manifold Learning Based Kernel Density Estimation

Yanovich Yu.

Institute for Information Transmission Problems, Russian Academy of Sciences, Moscow, Russia
yanovich.yury@ya.ru

The problem of an unknown high dimensional density estimation is considered. The support of its measure is supposed to be a low-dimensional data manifold. This problem arises in many data mining tasks, and the paper proposes a new geometrically motivated solution for the problem in manifold learning framework, including an estimation of an unknown support of the density.

Firstly, tangent bundle manifold learning problem is solved resulting in transforming high dimensional data into their low-dimensional features and estimating the Riemannian tensor on the Data manifold. After that, an unknown density of the constructed features is estimated with the use of appropriate kernel approach. Finally, with the use of estimated Riemannian tensor, the final estimator of the initial density is constructed.

Vector Fields Alignment on Manifolds via Contraction Mappings

Kachan O.

Higher School of Economics, Moscow, Russia
683009@gmail.com

According to the manifold hypothesis, high-dimensional data can be viewed and meaningfully represented as lower-dimensional manifold embedded in higher dimensional feature space. Manifold learning is a part of machine learning where an intrinsic data representation is uncovered based on the manifold hypothesis.

Many manifold learning algorithms were developed. The one called Grassmann&Stiefel Eigenmaps (GSE) is considered in the paper. One of GSE subproblems is a tangent spaces

alignment. An iterative algorithm is introduced for solving this problem. As a result, we have a significant gain in algorithm efficiency and time complexity.

Improving the Accuracy of Macroeconomic Time Series Forecast by Incorporating Functional Dependencies Between Them

Moiseev N.

Plekhanov Russian University of Economics, Moscow, Russia
Moiseev.NA@rea.ru

This paper presents a parametric approach to forecasting vectors of macroeconomic indicators, which incorporates functional dependencies between them. As it is possible to functionally bind together most of indicators we believe that using this information can help substantially decrease their forecast error. In this paper we propose to readjust traditionally obtained forecasts given a known analytical form of relationship between considered indicators by maximum likelihood method. We also derive a standard form of readjusted probability density function for each analysed indicator by normalizing its marginal distribution. In order to prove the efficiency of proposed method we conduct an empirical out-of-sample investigation regarding a simple example that comprises such macroeconomic indicators as Gross Domestic Product (GDP), GDP deflator and GDP in constant prices.

Finding chromatical polynomials using partition function of Pott's models

Mukhamedjanova S.

Kazan Federal University, Kazan, Russia
sofya_92@mail.ru

Let G be a graph with two distinguished vertices. There are m parallel paths between these vertices, $m > 1$, with arbitrary numbers of edges in each of them. We will call such graph a "necklace". The problems are:
1) to find the chromatical polynomial for the graph "necklace";
2) to find a chromatical polynomial for graph which represented as a ring of the graphs "necklace";
3) to find a chromatical polynomial for graph which is represented as the "necklace", each edge is substituted by the "necklace".

Our calculations are based on the the fact that the chromatic polynomial is a special case of the partition function of the the multivariate polynomial of Potts model. The weights of all edges are equal to -1. Using the parallel-reduction and series-reduction identities of edges for the multidimensional case the complicated graph was transformed into a simpler graph.

An approach to coefficients choice in the k-ary gcd algorithm

Dolgov D.

Kazan Federal University, Kazan, Russia
Dolgov.kfu@gmail.com

The greatest common divisor (GCD) is a basic arithmetic operation in a many computer algebra systems. K-ary gcd algorithm is one of the fastest algorithm for gcd computation. Let $A > B > 0$ are 2 n-bit integer numbers. We must find 2 integer coefficients x, y, such that $xA + yB = 0\ (mod\ 2^k)$ for some fixed integer k. We consider k as a power of 2.

Choice of coefficients. We choose t last bits of each numbers as coefficients x, y. Than we use *Euclid* gcd scheme: $gcd(A, B) = gcd(B, |(xA - yB)/k|)$ and so on. We associate with A, B the a, b coefficient vectors, which consist of the binary representation of A and B. In b there is always at least one zero. One of criteria to choose t variable: we must find a decreasing binary sequence in a and increasing binary sequence in b. We analyse this criteria and estimate the probability of maximum reduction.

Hidden Markov models and neural networks in forming investment portfolio

Novikov P, Valiev R.

Kazan Federal University, Kazan, Russia
novikov@it.kfu.ru

Common mathematical models used by investors for prediction of the future state of the financial market lose their efficiency if the macroeconomic situation gets worse. In this regard, it is desired to build models that minimize the losses in the formation of investment portfolio in the conditions of economic fluctuations. Many models describing economic fluctuations consider annual changes, which allows for the decrease of response time to the actual economical fluctuations. A model that predicts the future state of the economy on more recent data enables the choice of the optimal strategy for the formation of investment portfolio. In this paper, we propose an economical model that allows to determine the possible direction of change of the economic situation, which is helpful in making timely decisions on the strategy for the formation of investment portfolio. Our model is based on hidden Markov models and the multilayer perceptron.