**Prof. Vladimir Spokoiny**

**Course: Advanced statistical methods**

**Short Course Description**

This course introduces some important notions, approaches, and methods of nonparametric statistics. The main topics include smoothing and regularization, model selection and parameter tuning, structural inference, efficiency and rate efficiency, local and sieve parametric approaches. The study is mainly limited to regression and density models. The topics of this course form an essential basis for working with complex data structures using modern statistical tools.

**Course structure**: lectures, seminars, exam.

**Prerequisites:** Probability theory, linear algebra, mathematical analysis.

Dates and place:

Tu. 07.02 17:30 – 20:30 Lecture, NMU 401

We. 08.02 17:30 – 20:30 Seminar, NMU 310

Tu. 14.02 17:30 – 20:30 Lecture, NMU 401

We. 15.02 17:30 – 20:30 Seminar, NMU 310

Tu. 21.02 17:30 – 20:30 Lecture, NMU 401

We. 22.02 17:30 – 20:30 Seminar, NMU 310

\*NMU - Mосковский  центр непрерывного  математического  образования,

Независимый Московский Университет:

Москва, 119002, Большой Власьевский переулок, дом 11

Exam: 3.04 (Mo), 4.04 Tu. (written)

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| **Topics / Themes** |
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| # | Topic / Theme | Annotated summary of topic / theme |
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| 1 | Nonparametric Regression | Regression models: design, errors, and response function.Projection estimation. The case of orthogonal design.Bias, variance, risk of estimation, rate and accuracy, smoothness classes |
| 2 | Regularization and roughness penalty | Ridge regression, roughness penalty, penalized maximum likelihood estimation, impact of regularization, modeling bias, complexity, bias-variance trade-off |
| 3 | Model selection by SURE and AIC, Cross validation | Problem of model choice. Penalized model selection. Akaike criterion. Stein unbiased risk estimation. Parameter tuning by cross-validation. |
| 4 | Model section by smallest accepted | Ordered Model selection and multiple testing. Smallest accepted rule. Parameter tuning by propagation condition and multiplicity correction |
| 5 | Wavelet methods: hard and soft thresholding | Sequence space model. Wavelet decomposition. Nonlinear wavelet estimation. Hard and soft thresholding |
| 6 | Density model: Kernel and projection methods | Nadaraya-Watson estimator, high-order kernels. Rate of estimation. Reduction to sequence space model. Wavelet density estimation |