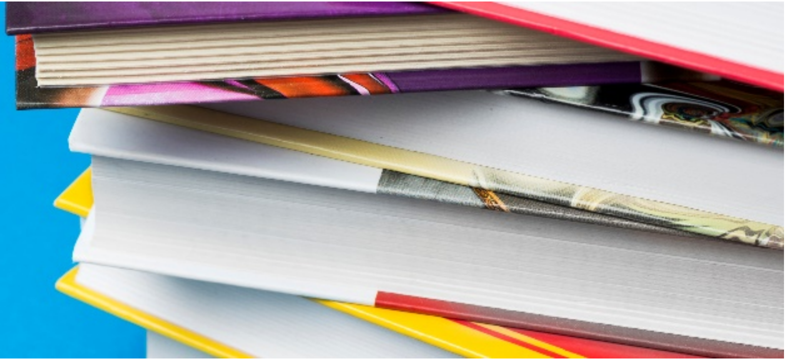

Full Syllabus

Course Title
Topics in Inverse Problems and Super-Resolution

Lecturer
Dr. Dmitry Batenkov

Semester
2020/1

Course requirements
Analysis, linear algebra, Fourier analysis, numerical analysis.
Elementary coding skills (in any scientific computing language).

Final grade components
10% Final quiz; 90% final project

Course schedule

Class	Subject and Requirements (assignments, reading materials, tasks, etc.)
1	Introduction and overview. Ill-posed and well-posed problems. Hadamard's criterion. Compact operators and integral equations.
2	Picard's theorem. Truncated SVD. Regularization schemes, convergence. Source conditions.
3	Tikhonov regularization. Iterative methods. Discretization methods.
4	Sparsity and sparse regularization.
5	Introduction to mathematical super-resolution. Resolution in bandlimited systems. Rayleigh-Nyquist limit. Time-frequency limiting.
6	Super-resolution by extrapolation and analytic continuation.
7	Super-resolution of sparse objects: Existence and uniqueness of solutions.
8	Algebraic methods for sparse super-resolution.
9	Stability analysis of sparse super-resolution under geometric constraints.
10	Minimax bounds for sparse super-resolution. Connections to harmonic analysis.
11	Inverse problems in imaging.
12	Recent trends in data-driven inversion methods.
13	Final quiz.

Reading

1. J. L. Mueller and S. Siltanen, *"Linear and Nonlinear Inverse Problems with Practical Applications"*. SIAM, 2012
2. Per Christian Hansen, *"Discrete Inverse Problems: Insight and Algorithms"*, SIAM, 2010
3. M.Bertero and P.Boccacci, "*Introduction to Inverse Problems in Imaging*", IOP Publishing, 1998
4. Batenkov, Dmitry, Gil Goldman, and Yosef Yomdin, "Super-Resolution of near-colliding Point Sources." *Information and Inference: A Journal of the IMA*, 2020. https://doi.org/10.1093/imaiai/iaaa005.
5. Devaney, Anthony J. *Mathematical foundations of imaging, tomography and wavefield inversion*. CUP, 2012.
6. Arridge, Simon, Peter Maass, Ozan Öktem, and Carola-Bibiane Schönlieb. "Solving Inverse Problems Using Data-Driven Models." *Acta Numerica* 28 (May): 1–174, 2019. https://doi.org/10.1017/S0962492919000059.

Comments
The teaching is conducted in English. Final project: Read a paper (one or more) from research literature related to the topics of the course, either from a predefined list or suggest your own. Summarize and implement the method(s). Write a report and provide working code.