**Abstract**

In this course, we address a wide spectrum of questions related to theoretical justification of optimization algorithms and complexity of optimization problems. We start from deriving the lower complexity bounds for different classes of Black-Box convex optimization problems and providing them with optimal methods. Our second topic is the second-order schemes with global complexity guarantees. After that, we discuss different approaches of Structural Optimization, which lead to significant acceleration of Black-Box minimization methods. The first of these topics is the theory of self-concordant functions and polynomial-time interior-point methods. For large-scale optimization, we describe the smoothing technique. Finally, we present new subgradient methods with sublinear iteration cost, which can be applied for solving huge-scale optimization problems.

**Detailed program**

**Lecture 1. Complexity of Black-Box Optimization**
- Difficult problems
- Lower complexity bounds for Convex Optimization
- Optimal methods

**Lecture 2. Second order methods. Systems of nonlinear equations**
- Globally convergent second-order schemes
- Cubic regularization for Newton Method
- Modified Gauss-Newton method

**Lecture 3: Structural Optimization: Interior-point methods**
- self-concordant functions
- self-concordant barriers
- application examples.

**Lecture 4. Structural Optimization: Smoothing Technique**
- explicit model of objective function
- smoothing
- application examples

**Lecture 5. Huge-scale optimization**
- sparsity in optimization problems
- coordinate-descent schemes
- gradient methods with sublinear cost of iteration