Introduction to Engineering Optimization

Lecturer: Prof. Sławomir Koziel (Reykjavik University, Iceland)

Course description:

The course is an introduction to modern optimization techniques. Formulation of the optimization problem will be followed by the discussion of typical challenges that one may encounter while solving real-world optimization tasks: non-differentiability and non-smoothness of the objective functions, numerical noise, multiple local optima, computationally expensive functions, etc. We will talk about the classification of optimization methods, their relative strengths and weaknesses, as well as recommended areas of applications. The presented approaches will be explained using illustrative examples. Selected real-world test cases will also be presented.

During the lecture, a number of optimization techniques will be discussed in some detail, including basic gradient-based algorithms (e.g., conjugate-gradient, Newton- and quasi-Newton methods), derivative-free methods (pattern-search, Nelder-Mead algorithm), stochastic search techniques and meta-heuristics (random search, evolutionary strategies, genetic algorithms, particle swarm optimizers, differential evolution). We will also formulate the multi-objective optimization problem as well as typical solution approaches including scalarization, goal-attainment method as well as Pareto-front approach. Multi-objective optimization using evolutionary methods will also be addressed.

An important part of the lecture will be devoted to cover surrogate modelling and surrogate-based optimization (SBO) techniques. We will briefly discuss design of experiment techniques, various ways of constructing function-approximation and physically-based surrogate models, as well as some specific SBO algorithms (response correction techniques, space mapping, manifold mapping, surrogate management framework, etc.). Advantages and difficulties of SBO methods will also be discussed. Our considerations will be illustrated using a number of application examples, mostly from microwave engineering area.

Syllabus of the lecture subjects (enlisted):

1. Repetition of necessary mathematical concepts
2. Classical unconstrained optimization: gradient-based and derivative-free methods
3. Stochastic and population-based search methods
4. Multiobjective optimization
5. Fundamentals of surrogate-based optimization
6. Surrogate modelling: design of experiments, surrogate construction and validation
7. Surrogate-based optimization methods

Projekt „Rozwój interdyscyplinarnych studiów doktoranckich na Politechnice Gdańskiej w zakresie nowoczesnych technologii" jest współfinansowany przez Unię Europejską w ramach Europejskiego Funduszu Spolecznego.

TERMINY WYKLADÓW			
Data	**Dzień tygodnia**	**Godzina**	**Sala**
2013-11-04	Poniedziałek	9-12	320 (Stary Gmach WETI)
2013-11-05	Wtorek	9-12	320 (Stary Gmach WETI)
2013-11-06	Środa	9-12	320 (Stary Gmach WETI)
2013-11-07	Czwartek	9-12	320 (Stary Gmach WETI)
2013-11-08	Piątek	9-12	320 (Stary Gmach WETI)

Projekt „Rozwój interdyscyplinarnych studiów doktoranckich na Politechnice Gdańskiej w zakresie nowoczesnych technologii" jest współfinansowany przez Unię Europejską w ramach Europejskiego Funduszu Spolecznego.