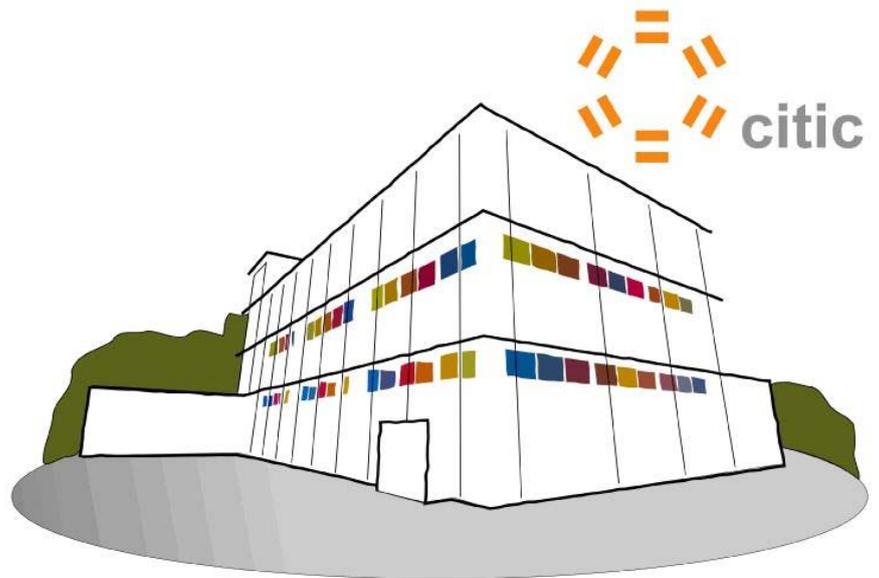




2014

# Course Convex Optimization in Communications Engineering



***Prof. Dr.-Ing. Wolfgang Utschick***

***Signal Processing Group  
Technische Universität München , Germany***

A Coruña, from June 27<sup>th</sup> to July 10<sup>th</sup>, 2014.

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## Convex Optimization in Communications Engineering Course (30 hours)

### DESCRIPTION FOCUS

Optimization is a mathematical framework with a tremendous impact on modern communications engineering. Within this framework, convex optimization enjoys a highlighted role due to its potential for the design of numerical algorithms with low complexity (polynomial runtime) which makes it an efficient toolbox for the solution of optimization problems in practical applications. From a more recent perspective, convex optimization is considered as a means for the modeling of complex systems, which leads to new directions in the designs of signal processing and communication systems.

Both perspectives of convex optimization are of great importance for communications engineering, where the problems of interest are for instance the allocation of scarce resources like bandwidth or power, routing decisions in communication networks, the estimation of parameters from noisy observations, etc.

The range of solutions that is considered acceptable very much depends on the problem at hand, but we are often not interested in some acceptable solution and want to find the best one. A systematic approach to figure out the best solution to a problem is to formulate an optimization problem that takes into account the goal (objective), the design parameters, and all constraints these parameters must satisfy. Frequently, a tradeoff between performance and costs (in terms of resources) or a tradeoff between several users is inevitable. To this end, those preferences must be incorporated into the objective as well such that they are reflected in the solution. In other words, in order to formulate an optimization problem, we must of course model the underlying problem in an appropriate way. This is a very important aspect of optimization because the problem formulation eventually determines if and how efficiently an optimization problem can be solved.

In this course we introduce the fundamental basics of convex optimization and show how the mathematical framework provides new means for the design and improvement of communication systems.

### WHO SHOULD PARTICIPATE?

- Master and PhD students in diverse science and engineering postgraduate courses.
- Any student and/or professional working with optimization in her/his field.
- Any student/professional wishing to refresh her/his theoretical knowledge and get practical experience in convex optimization techniques.

### COURSE DATES and LOCATION

- Ten days (30 lecture hours) from June 27<sup>th</sup> to July 10<sup>th</sup>, 2014 at the Facultad de informática (classroom A2.3b), Campus de Elviña, 15071 A Coruña, SPAIN.

## COURSE METHODOLOGY AND SCHEDULE

- Two sessions everyday of 90 minutes each
- First session from 9:30 to 11:00. Classroom A2.3b
- Second session from 11:30 to 13:00. Classroom A2.3b

## TOPICS

- Introduction: basic definitions and fundamentals, problem statement.
- Convex analysis: convex sets, convex functions.
- Linear programming: extremal points and directions, simplex algorithm.
- Optimality conditions: Fritz John conditions, Karush-Kuhn-Tucker conditions, constraint qualifications.
- Lagrangian duality: duality theorems.
- Algorithms: general concept, unconstrained optimization, constrained optimization.
- Solutions for the dual problem: subgradient method, cutting plane algorithm.
- Interior-point method: barrier functions, IP algorithm.
- Applications: problems from multiuser information theory, resource allocation, parameter optimization in layered and distributed communication systems.

## INSTRUCTOR

### *Dr. Wolfgang Utschick*

Wolfgang Utschick completed several industrial education programs before he received the diploma and doctoral degrees in electrical engineering, both with honors, from Technische Universität München (TUM). In this period, he held a scholarship of the Bavarian Ministry of Education for exceptional students. From '98 - '02, he co-directed the Signal Processing Group at the Institute of Circuit Theory and Signal Processing at TUM, and from '00 to '02 he was consulting in 3GPP standardization in the field of multi-element antenna systems. In 2000, he was a visiting researcher at ETH Zürich, and in 2002 Dr. Utschick was appointed Professor at TUM where he is director of the Fachgebiet Methoden der Signalverarbeitung (Institute for Signal Processing).



Dr. Utschick teaches courses on Signal Processing, MIMO Systems, Stochastic Processes, and Optimization Theory in the field of Wireless Communications and Signal Processing applications. In 2005, he has been guest professor at the University of Edinburgh and since 2011 he is serving as a regular guest professor at the Singapore Institute of Technology, where he teaches undergraduate and graduate courses.

He holds some 20 patents in the field of multi-antenna signal processing and has authored and co-authored more than 300 technical articles in international journals and conference proceedings.

He has edited several books and is founder and editor of the Springer book series Foundations in Signal Processing, Communications and Networking.

Dr. Utschick has been Principal Investigator in multiple research projects funded by the German Research Fund (DFG). He currently serves as a coordinator and spokesman of the German DFG focus program Communications over Interference limited Networks (COIN) which is devoted to topics as cooperative communications, crosslayer design, ad-hoc wireless networks, etc.

In 2006, Dr. Utschick received a Teaching Award from the student association at TUM and in 2007 he received the ITG Preis from the Informationstechnische Gesellschaft (Award of the German Society for Information Technology). In 2009 and 2010, he was co-recipient of a best paper award and co-author of a GOLD paper awarded contribution at the IEEE Globecom Conference. He is co-author of a best paper awarded publication at the IEEE SPS SPAWC 2013 workshop, and in 2014 his proposal for a new concept of teaching Stochastic Processes in engineering has been awarded by the TUM Freisemester Lehre, a sabbatical leave for teaching preparation.

Since 2011 he is in charge of study affairs (Dean of Studies) and member of the steering committee of the Faculty of Electrical Engineering and Information Technology. In 2014 he has been elected Chair of Deans of Studies at TUM and member of the TUM Extended Board of Management.

### FREE COURSE REGISTRATION

E-mail [proyectos@citic-research.org](mailto:proyectos@citic-research.org) before June 24<sup>th</sup>, 2014, with

- Complete name,
- Contact phone,
- Position,
- Company or institution,
- e-mail.

### SPONSORSHIP

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