



NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS  
DEPARTMENT OF ECONOMICS

Conference on Approximation and Optimization:  
Algorithms, Complexity, and Applications

June 29–30, 2017, Athens, Greece  
<http://caoaca.com/>

# Organizing Committee

## COMMITTEE

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## CONFERENCE SECRETARY

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# Invited Speakers

1. Andrey Bogatyrev (Russian Academy of Sciences and Moscow Institute of Physics and Technology)
2. Coralia Cartis (University of Oxford)
3. Rev. Michael Cullinan (Maryvale Higher Institute of Religious Sciences)
4. Ioannis Demetriou (National and Kapodistrian University of Athens)
5. Dimitri Hristou-Varsakelis (University of Macedonia)
6. Valery Kalyagin (National Research University - Higher School of Economics, The Nizhny Novgorod branch)
7. Ilias Kotsireas (Wilfrid Laurier University)
8. Panos Pardalos (University of Florida)
9. Michael Rassias (University of Zürich)
10. Georgios Stavroulakis (Technical University of Crete)
11. Michael Vrahatis (University of Patras)
12. Zaikun Zhang (Hong Kong Polytechnic University)

# Generalizations of the Bolzano Theorem

Th. June 29,  
15:00–15:45

Michael N. Vrahatis

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Generalizations of the Bolzano theorem (also called intermediate value theorem) are presented. These generalized theorems are particularly useful for the existence of a solution of a system of nonlinear equations in several variables as well as for the existence of fixed points of functions and the localization of extrema of objective functions.

The only computable information required by the hypotheses of these generalized theorems is the algebraic sign of the function that is the smallest amount of information (one bit of information) necessary for the purpose needed, and not any additional information. Thus, these theorems are of major importance for tackling problems with imprecise (not exactly known) information. This kind of problem occurs in various scientific fields including mathematics, economics, engineering, computer science, biomedical informatics, medicine and bioengineering among others. This is so, because, in a large variety of applications, precise function values are either impossible or time consuming and computationally expensive to obtain.

*Key words:* Bolzano theorem, intermediate value theorem, existence theorems, roots, fixed points, extrema, nonlinear equations, optimization, imprecise problems.

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