Extrapolation methods and their applications

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Timetable: 4 lectures, 6 hrs.

Course requirements: No special requirement is needed for this course. Only some fundamental knowledge of numerical analysis, but it could be acquired simultaneously with the lectures.

Research field: Numerical Analysis

Aim: These lectures are intended to students and researchers in pure and applied mathematics, in numerical analysis, and in scientific computing. An introduction to extrapolation methods and several applications will be described. Free numerical software packages will also be presented, allowing the users to try their applications easily.

Course contents:

1. Sequence transformations and convergence acceleration

When a sequence is slowly converging, one can transform it, without modifying its terms, into a new sequence which, under some assumptions, converges faster to the same limit. The theory of such sequence transformations will be studied.

- 2. What is an extrapolation method? Sequence transformation are showed to be, in fact, based on the idea of extrapolation which will be explained.
- 3. Various extrapolation methods We will describe various sequence transformations and the recursive algorithms which are used for implementing them.
- 4. Vector sequence transformations There exist special sequence transformations for accelerating the convergence of sequences of vectors. They will be reviewed.
- 5. Software
 - The main numerical software packages will be presented, together with their use.
- 6. Applications

Sequence transformations and extrapolation algorithms have many applications outside the domain of convergence acceleration. We will consider the following ones

- (a) Web search
- (b) Regularization of linear systems
- (c) Acceleration of Kaczmarz method
- (d) Fixed point iterations
- (e) Computation of matrix functions
- (f) Nonlinear integral equations

References

- 1 Slides of the lectures provided to the students.
- 2 C. Brezinski, M. Redivo-Zaglia, *Extrapolation Methods. Theory and Practice*, North–Holland, Amsterdam, 1991.
- 3 A. Sidi, *Practical Extrapolation Methods. Theory and Applications*, Cambridge University Press, Cambridge, 2003.
- 4 A. Sidi, Vector Extrapolation Methods with Applications, SIAM, Philadelphia, 2017.
- 5 E.J. Weniger, Nonlinear sequence transformations for the acceleration of convergence and the summation of divergent series, Computer Physics Reports, 10 (1989) 189-371.
- 6 J. Wimp, Sequence Transformations and their Applications, Academic Press, New York, 1981.