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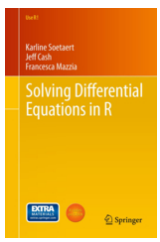
On "Solving differential equations in R" by K. Soetaert, J. Cash, and F. Mazzia



There is a number of powerful software packages intended to solve numerical problems, and differential equations in particular. First of all, we can mention MATLAB, Maple and Mathematica. Recently to that list we can add R. The advantage of using R as compared to the previously mentioned programs, which are rather expensive, is that R is an open source software. At the same time, the recent development makes R a very powerful and flexible software for solving differential equations.

The book "Solving differential equations in R"[1] describes the present stage of development of the R packages intended to solve differential equations. Consecutive chapters focus on several aspects of ODE's: initial value problems, differential algebraic equations, boundary value problems and delayed differential equations. There is also a chapter on partial differential equations. From the point of view of the R software the book presents the following R packages: **deSolve**, **rootSolve**, **deTestSet**, **ReacTran** and **bvpSolve**. The package **deSolve** contains the majority of integration methods for differential equations. It contains a large number of Runge-Kutta methods, both explicit and implicit, and a large variety of multistep methods (Adams methods). These methods can be applied to solve initial value problems for both non-stiff and stiff ODE systems. Delayed and algebraic differential equations can be solved using specially designed functions form the package **deSolve**. Algebraic differential equations can also be solved by special methods from the **deTestSet** package. The package **bvpSolve** is dedicated to boundary value problems which can be solved by shooting, MIRK or collocation methods.

Solving partial differential equations in R requires an additional effort from the user. The idea is to reduce a particular PDE to a system of ODE's or a system of algebraic equa-

[1] K. Soetaert (Royal Netherlands Institute for Sea Research, Netherlands); J. Cash (Imperial College, UK); F. Mazzia (University of Bari, Italy), "Solving differential equations in R", Springer, 2012. Approx. 250 p. 70 illus. Softcover. ISBN: 978-3-642-28069-6

tions and then solve such a system using tools available in R. For simple parabolic or hyperbolic equations the method of line can be used. The resulting system of ODE's can be solved by special functions from the **deSolve** package. For elliptic equations a finite difference approximations can be applied which gives a system of algebraic equations solvable by a function from the package **rootSolve**. A grid generation for diffusive and adjective transport terms in analyzed PDE's can be performed automatically by functions from the package **ReacTran**.

Subsequent topics of the book are presented in a similar manner. First comes a chapter with relevant theoretical results on existence of solutions, limits of solvability, discretization methods and stability problems. The presentation is accompanied by a large number of references which contain more detailed information. Then follows a chapter with the R implementation together with a thorough description of relevant packages. These implementations are illustrated by a large number of well-known examples. Most of important ODE's models are treated as illustrations. Logistic equation, Lorenz model, Arenstorf orbits, van der Pol equation, Josephson junctions, pendulum problem, Sturm-Liouville problem and a large number of models from biology and medicine – all that can be found in some place in the book.

To whom the book is intended? First of all to practitioners: researchers and graduate students who need solutions to differential equations. The R software gives them a possibility to obtain solutions without time consuming computer coding. In addition, a large number of R graphic and statistical functions can improve visualization of the solution obtained. There is however a word of warning to non-expert in numerical analysis. There is a number of traps in numerical methods for differential equations related to solvability or numerical stability problems. Majority of these traps is addressed in the theoretical chapters of the book. But these theoretical chapters are written in a very concise form. A mathematical theorem is sometime reported just in one sentence. Hence, when the reader is not an expert, he should read very carefully a relevant part of the theoretical introduction before starting computations to avoid frustration when the result does not fit the expectations.

The book can also be interesting to experts in differential equations. I strongly recommend the book to all courses in ODE's and numerical ODE's as a valuable source of interesting examples and illustrations to the course. It can be as well an interesting source of problems for students enabling them to test lectured topics and experiment with new models. Finally, even experts in the field can find in the book tasty remarks on the state of the art of numerical methods for differential equations.[2]

[2] On the publisher web page there is access to The table of contents, Preface and Chapter 3 of the book.

O książce "Solving differential equations in R" autorstwa K. Soetaert, J. Cash i F. Mazzia

Streszczenie. Książka przedstawia możliwości, jakie daje pakiet **R** przy rozwiązywaniu równań różniczkowych. Autorzy dość pobieżnie omawiają teoretyczne podstawy rozwiązywania równań różniczkowych, skupiając się na pokazaniu możliwościach jakie daje **R** przy numerycznym rozwiązywaniu równań. Rekompensatą za brak rozbudowanego wstępu teoretycznego są liczne odwołania do literatury (często przytaczane są konkretne numery stron) dotyczące problemów teoretycznych a także metod numerycznych. Książka stanowi znakomite wsparcie dla osób, które przede wszystkim potrzebują sprawnie uzyskać wyniki numeryczne dla konkretnego problemu bez konieczności studiowania metod numerycznych oraz żmudnego pisania kodu komputerowego. Książka może być też źródłem doskonałych przykładów ilustrujących wykład równań różniczkowych lub wykład metod numerycznych. Zaletą książki jest bogaty zbiór gotowych R-kodów dla konkretnych problemów. Stwarza to użytkownikowi możliwość samodzielnego eksperymentowania z modelowymi przykładami.

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