Electronic Transactions on Numerical Analysis.
Volume 35, pp. 57-68, 2009.

ISSN 1068-9613.

ETNA
Kent State University
http://etna.math.kent.edu

A FULL-NEWTON APPROACH TO SEPARABLE NONLINEAR LEAST SQUARES PROBLEMS AND ITS APPLICATION TO DISCRETE LEAST SQUARES RATIONAL APPROXIMATION*

CARLOS F. BORGES†

Abstract. We consider a class of non-linear least squares problems that are widely used in fitting experimental data. A defining characteristic of the models we will consider is that the solution parameters may be separated into two classes, those that enter the problem linearly and those that enter non-linearly. Problems of this type are known as separable non-linear least squares (SNLLS) problems and are often solved using a Gauss-Newton algorithm that was developed in Golub and Pereyra [SIAM J. Numer. Anal., 10 (1973), pp. 413–432] and has been very widely applied. We develop a full-Newton algorithm for solving this problem. Exploiting the structure of the general problem leads to a surprisingly compact algorithm which exhibits all of the excellent characteristics of the full-Newton approach (e.g. rapid convergence on problems with large residuals). Moreover, for certain problems of quite general interest, the per iteration cost for the full-Newton algorithm compares quite favorably with that of the Gauss-Newton algorithm. We explore one such problem, that of discrete least-squares fitting of rational functions.

Key words. separable nonlinear least squares, rational approximation

AMS subject classifications. 65F20, 65D10, 41A20

* Received August 30, 2008. Accepted for publication December 15, 2008. Published online on April 14, 2009. Recommended by M. Benzi.

† Department of Applied Mathematics, Naval Postgraduate School, Monterey, CA 93943 (borges@nps.edu).