MATH77 and *mathc90*

Mathematical Subprogram Libraries for Fortran 77 and ANSI C

Table of Contents

1. Introduction

1.0 Release 6.0 of MATH77
1.1 Purpose and Scope
1.2 Access to the MATH77 and *mathc90* Libraries
1.3 Conventions Followed in the Code and Documentation

2. Mathematical Functions

2.1 Inverse Hyperbolic Functions
2.2 Error Function
2.3 Gamma and Log-Gamma Functions
2.4 Bessel Functions J_0, J_1, Y_0 and Y_1
2.5 Bessel Functions of General Orders J_ν and Y_ν
2.6 Bessel Functions I_0, I_1, K_0 and K_1
2.7 { Empty }
2.8 Complete Elliptic Integrals K and E
2.9 Incomplete Elliptic Integrals
2.10 Exponential Integrals Ei and E_1
2.11 Finite Legendre Series
2.12 Finite Laguerre Series
2.13 Inverse Error Function and Inverse Complementary Error Function
2.14 Sine and Cosine Integrals
2.15 Procedures to Avoid Loss of Precision: $\ln(1+x)$, etc
2.16 Complex Error Function $w(z)$
2.17 Fresnel Integrals
2.18 Digamma or ψ Function
2.19 Incomplete Gamma Function Ratio
2.20 Binomial Coefficients

3. Pseudorandom Number Generation

3.1 Uniform Random Numbers
3.2 Gaussian (Normal) Random Numbers and Vectors
3.3 Random Numbers: Exponential, Rayleigh, and Poisson

4. Linear Systems of Equations and Linear Least-Squares

4.1 Square Nonsingular Systems of Linear Equations
4.2 Linear Least-Squares and Covariance Matrix
4.3 Singular Value Decomposition and Analysis
4.4 Sequential Preprocessing of Linear Least-Squares Data
4.5 Sequential Solution of a Banded Least-Squares Problem
4.6 Solution of a Positive-Definite System with Cholesky Factorization

©1997 Calif. Inst. of Technology, 2015 Math à la Carte, Inc.

5. Matrix Eigenvalues and Eigenvectors

5.1 Eigenvalues and Eigenvectors of a Symmetric Matrix
5.2 Eigenvalues and Eigenvectors of a Hermitian Complex Matrix
5.3 Eigenvalues of an Unsymmetric Matrix
5.4 Eigenvalues and Eigenvectors of an Unsymmetric Matrix

6. Matrix-Vector Utility Subprograms

6.1 Vector and Matrix Output
6.2 Extended Vector and Matrix Output
6.3 Basic Linear Algebra Subprograms (BLAS1)
6.4 One Householder Transformation

7. Polynomial Root Finding

7.1 Roots of a Polynomial
7.2 Roots of a Quadratic Polynomial
7.3 Compute Polynomial Coefficients from Roots

8. Nonlinear Equation Solving

8.1 Zero of a Univariate Function
8.2 Solve System of Nonlinear Equations
8.3 Check Code for Computing Derivatives

9. Minimization

9.1 Local Minimum of a Univariate Function
9.2 Local Minimum of a Multivariate Function, with Linear Constraints
9.3 Nonlinear Least-Squares

10. Finite Fourier Transforms

10.0 Overview of Fourier Transforms and Spectral Analysis
10.1 One-Dimensional Real Fourier Transforms
10.2 Trigonometric, Cosine, and Sine Fourier Transforms
10.3 Complex Fourier Transform
10.4 Multi-dimensional Real Fourier Transform
10.5 Primitive Fast Fourier Transform

11. Curve Fitting

11.1 Polynomial Least-Squares Curve Fit
11.2 Evaluation, Integration, and Differentiation of Polynomials
11.3 Conversion between Chebyshev and Monomial Representations of a Polynomial
11.4 Least-Squares Cubic Spline Fit
11.5 Least-Squares Data Fitting Using K^{th} Order Splines with Constraints
11.6 Low-level Subprograms for Operations on Splines

12. Table Look-Up and Interpolation

12.1 One-Dimensional Table Look Up, Interpolation, and Differentiation
12.2 Multi-Dimensional Table Look Up, Interpolation, and Differentiation
12.3 Table Look-up With Hermite Cubic Interpolation
12.4 C^0 and C^1 Surface Interpolation to Scattered Data

13. Definite Integrals (Quadrature)

13.0 Effective Use of the Quadrature Software
13.1 Numerical Evaluation of Integrals Over One Dimension
13.2 Numerical Evaluation of Integrals Over More Than One Dimension

14. Ordinary Differential Equations

14.1 Variable Order Adams Method for Ordinary Differential Equations
14.2 Explicit Runge-Kutta Method for Ordinary Differential Equations

15. Statistics

15.1 Basic Statistics and Histogram
15.2 Cumulative Distribution Function and Percentage Points for Normal Probability Distribution
15.3 Cumulative Distribution Function for Chi-Square Probability Distribution
15.4 Cumulative Distribution Function for Poisson Probability Distribution

16. Graphics

16.1 Character-based Graphics — One or More XY Graphs
16.2 Character-based Graphics — Single Print Line
16.3 Plotting Using TEX

17. Special Arithmetic

17.1 Computation Using Derivative Arrays or Univariate Taylor Series
17.2 Computation Using Partial Derivative Arrays or Multivariate Taylor Series
17.3 Double Precision Complex Computation

18. Sorting

18.1 Sorting One-dimensional Arrays in Memory
18.2 Sorting Data of Arbitrary Structure in Memory
18.3 Sorting Partially Ordered Data of Arbitrary Structure in Memory
18.4 Sorting Data Sets Too Large to Fit in Memory

19. Library Utilities

19.1 System Parameters
19.2 Error Message Processor
19.3 Extended Error Message Processor
19.4 Converting Codes to Different Versions
19.5 Checking the Installed Library
19.7 Checking and Output of Program Unit Interfaces

Appendix A. Files Required by Each Entry

Appendix B. Entry Names and Common Block Names

Appendix C. Usage of the *mathc90* Library

Appendix D. Function Prototypes for the *mathc90* Library

Index