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Cumulative Index to the ACM Algorithms

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Abstract

This report contains a cumulative index to the *Collected Algorithms of the ACM*. The algorithms are classified using the modified SHARE classification, several different views of which are provided in Chapter 1. The source codes of these routines originally appeared in the *Communications of the ACM* and, from Algorithm 493, in the *ACM Transactions on Mathematical Software*. All algorithms up to and including those appearing in the December 1991 issue of TOMS are included in the index. Information on how to obtain sources of the algorithms is given in Appendix A.

The references given in the index provide the original source in bold face followed by any published remarks or certificates. The format of each reference is

<journal> <volume>:<page>

where <journal> is C for CACM, T for TOMS and, in the single case of Algorithm 568, X for *Transactions on Programming Languages and Systems*.

The index was built from a bibliographic database which is an extension to that previously provided as Algorithm 620. This extended database plus a set of Fortran 77 routines to manipulate individual items has been published as [1]. The complete submitted remark is included in this report as Appendix B.

We have also added a perl script for performing a number of transformations of the original database. This is faster and more easily modified than the original Fortran routines. It is described in more detail in Appendix A.

We hope that users of numerical software will find this index a good starting point in their search for reliable public domain numerical routines.

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Chapter 1

The SHARE Classification

A1	Real Arithmetic, Number Theory
A2	Complex Arithmetic
B1	Trig and Inverse Trig Functions
B2	Hyperbolic Functions
B3	Exponential and Logarithmic Functions
B4	Roots and Powers
C1	Operations on Polynomials and Power Series
C2	Zeros of Polynomials
C5	Zeros of one or more Nonlinear Equations
C6	Summation of Series, Convergence Acceleration
D1	Quadrature
D2	Ordinary Differential Equations
D3	Partial Differential Equations
D4	Differentiation
D5	Integral Equations
E1	Interpolation
E2	Curve and Surface Fitting
E3	Smoothing
E4	Minimizing or Maximizing a Function
F1	Matrix Operations, including Inversion
F2	Eigenvalues and Eigenvectors of a Matrix
F3	Determinants
F4	Simultaneous Linear Equations
F5	Orthogonalization
G1	Simple Calculations on Statistical Data
G2	Correlation and Regression Analysis
G5	Random Number Generators
G6	Permutations and Combinations
G7	Subset Generators
H	Operations Research, Graph Structure
I5	Input – Composite
J6	Plotting
K2	Relocation
L2	Compiling
M1	Sorting
M2	Data Conversion and Scaling
O2	Simulation of Computing Structure
R2	Symbol Manipulation
S	Approximation of Special Functions
Y1	Physics Applications
Z	All Others

Figure 1.1: Classification by SHARE index

Z All Others
 S Approximation of Special Functions
 G6 Combinations and Permutations
 L2 Compiling
 A2 Complex Arithmetic
 I5 Composite Input
 O2 Computing Structure Simulation
 C6 Convergence Acceleration
 M2 Conversion and Scaling of Data
 G2 Correlation and Regression Analysis
 E2 Curve and Surface Fitting
 M2 Data Conversion and Scaling
 F3 Determinants
 D2 Differential Equations, Ordinary
 D3 Differential Equations, Partial
 D4 Differentiation
 F2 Eigenvalues and Eigenvectors of a Matrix
 B3 Exponential and Logarithmic Functions
 E4 Function Minimizing or Maximizing
 H Graph Structure, Operations Research
 B2 Hyperbolic Functions
 I5 Input—Composite
 D5 Integral Equations
 E1 Interpolation
 F1 Inversion of a Matrix
 F4 Linear Equations, Simultaneous
 F1 Matrix Operations, including Inversion
 B3 Logarithmic Functions and Exponential
 F2 Matrix Eigenvalues and Eigenvectors
 F1 Matrix Operations, Including Inversion
 F3 Matrix, Determinant of
 E4 Maximizing a Function
 E4 Minimizing a Function
 C5 Nonlinear Equations, Zeros of
 A1 Number Theory

Figure 1.2: SHARE classification by subject

C1	Operations on Polynomials and Power Series
H	Operations Research, Graph Structure
D2	Ordinary Differential Equations
F5	Orthogonalization
D3	Partial Differential Equations
G6	Permutations and Combinations
Y1	Physics Applications
J6	Plotting
C1	Polynomials, Operations on
C2	Polynomials, Zeros of
C1	Power Series, Operations on
B4	Powers and Roots
D1	Quadrature
G5	Random Number Generators
A1	Real Arithmetic
G2	Regression and Correlation
K2	Relocation
B4	Roots and Powers
M2	Scaling and Conversion of Data
C6	Series, Summation and Convergence Acceleration of
G1	Simple Calculations on Statistical Data
O2	Simulation of Computing Structure
F4	Simultaneous Linear Equations
E3	Smoothing
M1	Sorting
S	Special Functions, Approximation of
G2	Statistical Data, Correlation and Regression Analysis of
G1	Statistical Data, Simple Calculations on
G7	Subset Generators
C6	Summation of Series
E2	Surface and Curve Fitting
R2	Symbol Manipulation
B1	Trig and Inverse Trig Functions
F5	Vectors, Orthogonalization of
C5	Zeros of one or more Nonlinear Equations
C2	Zeros of Polynomials

Figure 1.2: SHARE classification by subject (contd.)

S04 Bernoulli and Euler Numbers and Polynomials
 S18 Bessel Function, Modified
 S19 Bessel Functions of Complex Argument
 S18 Bessel Functions of Pure Imaginary Argument
 S17 Bessel Functions of Real Argument
 S20 Bessel and Related Functions, Miscellaneous
 S14 Beta Function and Incomplete Beta Function
 S03 Binomial Coefficients
 S07 Circular Functions, Miscellaneous
 S19 Complex Argument, Bessel Functions of
 S13 Cosine Integrals
 S23 Curve-Fitting
 S04 Derivatives and Differences of Zero
 S15 Derivatives
 S04 Differences and Derivatives of Zero
 S23 Differentiation, Numerical
 S21 Elliptic Integrals and Functions
 S15 Error Integral
 S04 Euler and Bernoulli Numbers and Polynomials
 S13 Exponential Integrals
 S14 Factorial Function
 S03 Factorials
 S22 Functions: Miscellaneous Higher Mathematical Functions
 S14 Gamma Function and Incomplete Gamma Function
 S15 Hermite Polynomials and Functions
 S15 Higher Integrals
 S22 Higher Mathematical Functions, Miscellaneous
 S18 Imaginary Argument, Bessel Functions of
 S14 Incomplete Beta and Gamma Functions
 S13 Integrals of Exponentials, Logarithms, Sines, Cosines, etc.
 S21 Integrals, Elliptic
 S15 Integrals: Higher Integrals and the Error Integral

Figure 1.3: Classification of Special Functions

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 S23 Interpolation
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 S19 Kelvin Functions
 S16 Legendre Functions
 S13 Logarithmic Integrals
 S22 Miscellaneous Higher Mathematical Functions
 S18 Modified Bessel Functions
 S15 Moments
 S23 Numerical Differentiation and Integration
 S03 Partitions
 S14 Polygamma Function
 S15 Polynomials, Hermite
 S04 Powers and Inverse Powers, Sums of
 S14 Psi Function
 S13 Sine Integrals
 S07 Spherical Functions, Miscellaneous
 S04 Sums of Powers and of Inverse Powers
 S21 Theta Functions
 S07 Trigonometric Functions, Natural
 S04 Zero, Differences and Derivatives of

Figure 1.3: Classification of Special Functions (contd.)

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22	Riccati-Bessel Functions of First and Second Kind	C3:600 C13:448
44	Bessel Functions Computed Recursively	C4:177
49	Spherical Neumann Function	C4:179 T4:295
124	Hankel Function	C5:483 C8:790
163	Modified Hankel Function	C6:161 C6:522
236	Bessel Functions of the First Kind	C7:479 C8:105 T1:282
484	Evaluation of the Modified Bessel Functions $K_0(z)$ and $K_1(z)$ for Complex Arguments	C17:524
498	Airy Functions using Chebyshev Series Approximations	T1:372 T7:404
597	Sequence of Modified Bessel Functions of the First Kind	T9:242

S18

5	Bessel Function I Series Expansion	C3:240
6	Bessel Function I Asymptotic Expansion	C3:240
214	q -Bessel Functions $I_n(t)$	C6:662 C7:349
228	Q -Bessel Functions $\bar{I}_n(t)$	C7:295
511	CDC 6600 Subroutines IBESS and JBESS for Bessel Functions $I_\nu(x), J_\nu(x), \nu \geq 0, x \geq 0$	T3:93 T4:411

S19

57	Ber or Bei Function	C4:181 C5:392 C5:438
644	A Portable Package for Bessel Functions of a Complex Argument and Non-negative order	T12:265 T16:404

S20

88	Evaluation of Asymptotic Expression for the Fresnel Sine and Cosine Integrals	C5:280 C6:618
89	Evaluation of the Fresnel Sine Integral	C5:280 C6:618
90	Evaluation of the Fresnel Cosine Integral	C5:281 C6:618
213	Fresnel Integrals	C6:617 C7:661
244	Fresnel Integrals	C7:660
301	Airy Function	C10:291 C10:453
505	A List Insertion Sort for Keys with Arbitrary Key Distribution	T2:204

S21

55	Complete Elliptic Integral of The First Kind	C4:180 C6:166
56	Complete Elliptic Integral of The Second Kind	C4:180 C9:12
73	Incomplete Elliptic Integrals	C4:543 C4:544 C5:514 C6:69 C6:167
149	Complete Elliptic Integral	C5:605 C6:166 T4:95
165	Complete Elliptic Integrals	C6:163 C12:38
549	Weierstrass' Elliptic Functions	T6:112
577	Algorithms for Incomplete Elliptic Integrals	T7:398

S22

10	Evaluation of the Chebyshev Polynomial $T_n(X)$ by Recursion	C3:353 C4:181
12	Evaluation of the Laguerre Polynomial $L_n(X)$ by Recursion	C3:353
36	Tchebycheff	C4:151
110	Quantum Mechanical Integrals of Slater-Type Orbitals	C5:389 C5:393
111	Molecular-Orbital Calculation of Molecular Interactions	C5:390
132	Quantum Mechanical Integrals Over all Slater-Type Integrals	C5:551
184	Erlang Probability for Curve Fitting	C6:386
191	Hypergeometric	C6:388 C7:244 C17:589
192	Confluent Hypergeometric	C6:388 C7:244
227	Chebyshev Polynomial Coefficients	C7:295
282	Derivatives of e^x/x , $\cos(x)/x$ and $\sin(x)/x$	C9:272 C13:53
292	Regular Coulomb Wave Functions	C9:793 C12:278 C12:280 C13:573
300	Coulomb Wave Functions	C10:244 C12:279 C12:692 C16:308
327	Dilogarithm	C11:270
332	Jacobi Polynomials	C11:436 C13:449 C18:116
352	Characteristic Values and Associated Solutions of Mathieu's Differential Equation	C12:399 C13:750 C15:1074
388	Rademacher Function	C13:510
389	Binary Ordered Walsh Functions	C13:511

390	Sequency Ordered Walsh Functions	C13:511
490	The Dilogarithm Function of a Real Argument	C18:200 T2:112
537	Characteristic Values of Mathieu's Differential Equations	T5:112

S23

234	Poisson-Charlier Polynomials	C7:420 C8:105
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45	INTEREST	C4:178 C6:520
112	Position of Point Relative to Polygon	C5:434 C5:606
117	Magic Square (Even Order)	C5:435 C5:440 C6:39 C6:105
118	Magic Square (Odd Order)	C5:436 C5:440 C5:606 C6:39 C6:105
136	Enlargement of a Group	C5:555
148	Term of Magic Square	C5:605 C6:168 C6:168
199	Conversions Between Calendar Date and Julian Day Number	C6:444 C7:661
240	Coordinates On An Ellipsoid	C7:546
246	Graycode	C7:701 C8:382 T1:285 T11:441
252	Vector Coupling or Clebsch-Gordan Coefficients	C8:217
260	6-J Symbols	C8:492
261	9-J Symbols	C8:492
355	An Algorithm for Generating Ising Configuration	C12:562
364	Coloring Polygonal Regions	C12:685
391	Unitary Symmetric Polynomials	C13:512 C15:49
398	Tableless Date Conversion	C13:621 C15:918
428	Hu-Tucker Minimum Redundancy Alphabetic Coding Method	C15:360 C16:490
444	An Algorithm for Extracting Phrases in a Space-Optimal Fashion	C16:183
445	Binary Pattern Reconstruction from Projections	C16:185 C16:186
455	Analysis of Skew Representations of the Symmetric Group	C16:571
479	A Minimal Spanning Tree Clustering Method	C17:321 C18:119 T2:110
499	An Efficient Scanning Technique	T2:82
523	CONVEX: A New Convex Hull Algorithm for Planar Sets	T3:411
528	Framework for a Portable Library	T4:177 T5:524
532	Software for Roundoff Analysis	T4:388
536	An Efficient One-Way Enciphering Algorithm	T5:108
550	Solid Polyhedron Measures	T6:121
561	Fortran Implementation of Heap Programs for Efficient Table Maintenance	T6:444
564	A Test Problem Generator for Discrete Linear L_1 Approximation Problems	T6:615

568	PDS – A Portable Directory System	X3:162
588	Fast Hankel Transforms Using Related and Lagged Convolutions	T8:369
594	Software for Relative Error Analysis	T9:125
605	PBASIC – A Verifier Program for ANSI Minimal Basic	T9:391
606	NITPACK – An Interactive Tree Package	T9:418
607	Text Exchange System: A Transportable System for Management and Exchange of Programs and Other Text	T9:427
620	References and Keywords for <i>Collected Algorithms from ACM</i>	T10:359 T11:305 T16:401
622	A Simple Macroprocessor	T10:410

Appendix A

Availability of Data, Tools and Algorithm Sources

In addition to the Fortran code described in Appendix B there is a perl script for transforming the original database files into a number of more useful formats. Currently the perl script will generate

1. a `BIBTEX` database entry for each algorithm,
2. a cumulative index based on the `SHARE` classification like the one in [2],
3. a cumulative index based on the `GAMS` classification like the one in [3].

The algorithm databases available are

1. The `CALGO` algorithms published in *Communications of the ACM* from 1960–1975 and in *ACM Transactions on Mathematical Software* from 1975–,
2. The Applied Statistics algorithms published in *Applied Statistics* 1968–.

The databases and software are available via electronic mail or anonymous ftp from *unix.hensa.ac.uk*. The files are

- `acm.dbase` – the `CALGO` algorithms database,
- `acm.bib` – `BIBTEX` database of the `CALGO` algorithms,
- `as.dbase` – the Applied Statistics algorithms database,
- `as.bib` – `BIBTEX` database of the Applied Statistics algorithms,
- `bibeg.f`, `lib.f`, `shared.f` – Fortran 77 codes for operating on the database files. These codes are described in Appendix B,
- `bibop.sh` – a shar file containing the perl script, data files and man page as described above.

To obtain these files by electronic mail send mail of the form

```
send misc/netlib/bib/file
```

to `archive@unix.hensa.ac.uk` where `file` is replaced by the name of the file you require.

To obtain files via anonymous ftp, connect to `unix.hensa.ac.uk` (129.12.21.7) – the files are in the directory `misc/netlib/bib`. Compressed PostScript versions of [2] and [3] are also available for ftp in `misc/ukc.reports/reports/64` and `misc/ukc.reports/reports/71` respectively.

Please send bug reports, extensions to the perl script or further algorithm databases to `trh@ukc.ac.uk`.

Availability of algorithms

The sources to all algorithms published in TOMS and a number of those published in the Communications to the ACM are available via both e-mail and ftp.

To obtain copies via e-mail send a message of the form

```
send number from toms
```

where number is the number of the algorithm you require, e.g., to obtain algorithm 495 the message would be

```
send 495 from toms
```

to `netlib@unix.hensa.ac.uk` (UK/Europe) or `netlib@research.att.com` (US).

Using anonymous ftp connect to `unix.hensa.ac.uk` (129.12.21.7) from the UK and Europe or `research.att.com` (192.20.255.2) from the US, log in as anonymous and use your e-mail address as a password. To access the TOMS algorithms

```
cd netlib/toms
```

The algorithms currently available are

380, 386, 400, 403, 404, 406 – 408, 410, 413, 414, 419,
420, 432, 433, 458, 473 – 476, 478, 479, 483 – 485, 487,
488, 490, 493 –

Appendix B

A Remark on ACM TOMS Algorithm 620

We report on an enhanced version of the database originally reported in [6]. In this new version we have included all the information necessary to generate full bibliographic references. Extra information includes the author's name (including any accents), the page range of the original reference (rather than just the starting page), the month and year of publication and an abbreviated journal name. The programming language used to code the algorithm is also given. Any mathematical notation used within the algorithm title and accents in the author's name have been defined using $\text{T}_{\text{E}}\text{X}$ [4]. Following the practice used with $\text{BIB}_{\text{T}}\text{E}\text{X}$ [5], all letters within the title which need to remain capitalised in a printed version of the reference (e.g., Fortran, Bessel) are enclosed in braces.

The keywords and SHARE classification associated with each algorithm have been included with the main entry information rather than in a separate list as in [6]. Finally we have included references to all published remarks for each algorithm. These are in a compressed form which provides type (Remark or Certification), journal in which it appeared, volume, number, month and year of publication, page range and author.

The entry for each algorithm consists of either four or five records depending on whether there have been any published remarks. Each line in the file is restricted to 80 characters; records longer than this are continued on successive lines using a + in the first character position to denote that the line is a continuation line. Only the first record begins in character position one.

The first record gives details of the primary reference. The second and third are the author's name and title of the algorithm respectively. The keywords make up the fourth record. The first four records are always present. The final record provides details of remarks; individual fields within each remark reference are separated by commas and a semicolon is used to terminate each reference. Multiple remark references are treated as a single record.

As an example, the following entry is for algorithm 487

```
487   cacm  703  704 17 12  December 1974 s14   F
      J. Pomeranz;
      Exact Cumulative Distribution of the {K}olmogorov-{S}mirnov Statistic for
+ Small Samples
      goodness-of-fit testing;k-s statistic;k-s test;Kolmogorov-Smirnov test;
      R,toms,111,2,1,March,1976,J. Pomeranz;
+R,toms,285--294,3,3,September,1977,R. Kallman;
```

The first line should be interpreted as 'ACM CALGO Algorithm 487 appeared in Commun. ACM, Volume 17, Number 12, December 1974, pages 703–704'. The algorithm was implemented in Fortran and the modified SHARE classification is S14 (a sub-classification of the Special Functions).

The title spans two lines and contains two letters which must remain in upper case. The second remark is interpreted as being a Remark which appeared in ACM TOMS, Volume 3, Number 3 (second of the threes) in September 1977, pages 285–294. The author was R. Kallman.

We have provided Fortran routines which read in a reference in this compressed form and split the information up into a number of variables stored in a pair of common blocks. A template showing how to use these routines is given in Figure B.1. The two common blocks CREFNO and CREFST,

```

*
*  TEMPLATE FOR USE OF GETREF
*
*      LOGICAL GETREF
*
*  Insert COMMON block definitions here
*
*  Set up i/o channels and open data file
*  (This routine contains a possibly machine dependent
*  OPEN statement)
*      CALL SETUP
*
*  Set up output file -- application dependent routine
*      CALL OUTFIL
*
*  Initialize input buffer for references
*  a call to initrfr must precede calls to getref
*      CALL INITRF
*
*  Process all references
*  10 IF (GETREF()) THEN
*      process current reference
*      GO TO 10
*  END IF
*
*

```

Figure B.1: Template code for processing references

holding numerical and character data respectively, are defined by

```

INTEGER NUMBER, PAGEND, PAGEST, VOLUME, YEAR
COMMON /CREFNO/VOLUME, NUMBER, YEAR, PAGEST, PAGEND

INTEGER AUTLEN, TITLEN, KEYLEN, OTHLEN
PARAMETER (AUTLEN=80, TITLEN=160, KEYLEN=400
+          , OTHLEN=300)
CHARACTER AUTHOR(AUTLEN), KEYWDS(KEYLEN),
+          OTHERS(OTHLEN), TITLE(TITLEN)
CHARACTER ALABEL*(6), JOURNL*(4), MONTH*(9),
+          LANG*(3), SHARE*(3)

```

```
COMMON /CREFST/ALABEL, JOURNAL, MONTH, LANG, SHARE, AUTHOR,  
+      TITLE, KEYWDS, OTHERS
```

where

- JOURNAL contains the journal in which the algorithm was published (possible values are cacm, toms or topl),
- VOLUME, NUMBER, MONTH and YEAR store the volume, number, month and year of publication of the main reference,
- PAGEST and PAGEND give the page range of the main reference,
- the author and title are stored in the arrays AUTHOR and TITLE,
- the algorithm number (in two instances this contains a letter), implementation language (F = Fortran, A60 = Algol 60, PLI = PL1, R = Ratfor, N = None), and the Share index are placed in ALABEL, LANG and SHARE respectively;
- KEYWDS is an array containing the list of keywords separated by semicolons,
- the array OTHERS stores associated Remarks and Certifications. Each remark is separated by a semicolon and contains, as a list separated by commas
 - type of remark (R = Remark, C = Certification),
 - journal of publication (cacm or toms)
 - page range – either a pair of number separated by -- or a single integer for a one page remark,
 - the volume, number, month and year of the publication,
 - the author.

Two example programs are included which use these routines to generate a BIB_TE_X database and a cumulative index sorted by the SHARE index.

Bibliography

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