SIGNUM
NEWSLETTER

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SIGNUM
Special Interest Group on Numerical Mathematics
Association for Computing Machinery

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(313-764-9409)

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SIGNUM Newsletter

The SIGNUM Newsletter is published at irregular intervals
a few times per year by the Special Interest Group on Numerical
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Material for the Newsletter is solicited and should be
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Signed articles appearing in this issue are not refereed;
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Inquiries regarding SIGNUM membership, subscriptions to the
Newsletter and back or missing issues should be made to
SIGNUM, c/o ACM, 1133 Avenue of the Americas, New York, NY 10036.
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<td>Dec. 8-10</td>
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<td>April 18-20</td>
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<td>Aug. 14-18</td>
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SIGNUM BOARD

Four new members of the Board of Directors were elected as a result of last summer's balloting. They are Peter Businger of Bell Telephone Laboratories at Murray Hill, Patricia Eberlein of the State University of New York at Buffalo, Morven Gentleman of the University of Waterloo in Ontario, and Bruce McDonald of the Office of Naval Research in Washington, D.C.

The Board, officers and international coordinators met in August during the IFIP Congress in Yugoslavia. Six Board members, three officers and two coordinators were present.

Moler reported on plans for the SIGNUM - SIAM joint meeting. He also described some preliminary efforts being made to establish an IFIP Working Group on subroutine certification. Traub initiated a discussion of possibilities for other joint meetings involving other ACM SIGs and SICs.

Varah made a plea for greater involvement by numerical analysts in solving big, difficult, interdisciplinary problems. He feels that many numerical analysts are interested in such projects, but that their efforts are not adequately described in the literature. A lively discussion followed, but no definite plans for action by SIGNUM were made.

Stuart Lynn has resigned as chief international coordinator. He will be replaced by Robert Barnhill of the University of Utah. Barnhill is on sabbatical leave this year and is visiting Brunel University in Uxbridge, England.

ROYAL IRISH ACADEMY CONFERENCE

The National Committee for Mathematics of the Royal Irish Academy is holding a conference on Numerical Analysis at University College Dublin from 14th to 18th August 1972. Invited speakers include:

L. Collatz  
L. Fox  
H. O. Kreiss  
C. Lanczos  
J. L. Lions  
G. I. Marchuk  
P. Raviart  
G. Strang  
J. L. Synge  
V. Thomee  
E. Vitasek  
J. H. Wilkinson

A limited number of contributed papers of 20 minutes duration will also be accepted. Titles should be submitted by 1st May 1972. Reduced rates for travel and accommodation will be available to participants from abroad. A programme of social events will be arranged for both the participants and their families. The proceedings of the Conference will be published. Further details may be obtained from the Director, Dr. J. Miller, School of Mathematics, Trinity College, Dublin 2, Ireland.
SIGNUM - SIAM JOINT MEETING

SIGNUM and the Society for Industrial and Applied Mathematics will hold a joint meeting October 16 through 18, 1972, in Austin, Texas, at the Sheraton Crest Hotel. The meeting will be devoted to aspects of numerical analysis with an emphasis on surveys and applications. The program committee is chaired jointly by G. W. Stewart and David Young representing SIAM and Cleve Moler representing SIGNUM. The other members of the program committee are R. E. Barnhill, E. W. Cheney, A. Feldstein, G. H. Golub, John Rice, J. F. Traub and R. S. Varga.

The meeting will follow the usual format of SIAM Fall Meetings. There will be a dozen invited papers, several sessions of short contributed papers, a panel discussion and a few social events. The invited addresses will be distributed primarily in three areas: algebraic computations and mathematical programming, approximation theory and numerical analysis, and implementing numerical methods for partial differential equations. The panel will discuss the historical development of numerical analysis.

If enough algorithmically oriented contributed papers are submitted they will be organized into a special session. The deadline for submitting abstracts of contributed papers is June 31, 1972. Abstracts should be sent to SIAM, 33 South 17th Street, Philadelphia, Pa. 19103.

PRINCETON CONFERENCE

The Sixth Annual Princeton Conference on Information Sciences and Systems will be held at Princeton University on March 23-24, 1972. Authors are invited to submit papers describing new advances, applications and ideas in the fields of computer science, communication theory, system and circuit theory, including contributions which explore the application of these and related disciplines to current societal issues. For further information, contact Professor Murray Edelberg, Department of Electrical Engineering, Princeton University, Princeton, NJ 08540.

COMPUTERS IN UNDERGRADUATE CURRICULA

A conference will be held June 12-14, 1972, in Atlanta, Georgia, to disseminate information about applications of computers in undergraduate education. Papers are solicited in a wide variety of fields within the theme of the conference and should be submitted by January 15. A brochure with further information is available from the sponsoring organization, Computer Sciences Project, Southern Regional Education Board, 130 Sixth Street, N.W., Atlanta, Georgia 30313.
Speakers and topics during the past year were as follows.

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<td>Solution of Ill-Posed Problems</td>
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<td>Burton Zeldon</td>
<td>Allen's Method (for differential equations)</td>
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<td>Richard W. Hamming</td>
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<td>John R. Rice</td>
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<td>Alan Schumitzky</td>
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<td>William Murphy</td>
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<td>Fred T. Krogh</td>
<td>Two Topics in Ordinary Differential Equations</td>
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Current Officers are: Chairman, Fred Krogh; Vice Chairman, John Radbill; Secretary, Florence Anderson; and Treasurer, Verda Acker.

Los Angeles SIGNUM meets on the second Wednesday of the months October through June inclusive. Meetings are currently held at the Ramada Inn, 9620 Airport Boulevard, Los Angeles. Meetings follow the format: 6:00-7:00 Cocktail hour; 7:00-8:00 Dinner; 8:00-9:00 Technical talk. For further information contact Fred Krogh, Jet Propulsion Laboratory, 213-354-6127.
Collaborative Research Toward the Development of a Certified Subroutine Library

Argonne National Laboratory, Stanford University and The University of Texas at Austin, in cooperation with various test sites, have begun a collaborative effort to certify and disseminate mathematical software. The National Science Foundation is supporting this two-year venture, whose purpose is to develop ways of supplying the scientific computing community with highly reliable subroutines. The project is called NATS, an acronym for the four primary institutions, or for National Activity to Test Software.

The project has two stages, characterized as testing and distribution. During the first stage, selected software is tested, first, at the three principal institutions and then at field test sites. During the second stage the routines which have undergone the rigors of testing are distributed as certified programs from a software information exchange center at Argonne.

The first stage is well under way with a collection of Fortran versions of thirty matrix eigenvalue programs, whose Algol originals appear in Springer's Handbook for Automatic Computation, Vol. II, Linear Algebra by J. H. Wilkinson and C. Reinsch. A control program which permits high level language descriptions of matrix eigensystem problems will also be available. The project will also undertake testing and distribution of a set of routines for computing selected special functions of mathematical physics.

The machines available to field test participants will permit use of the codes in a variety of environments. These include IBM 360 machines at Ames Laboratory, Argonne, The University of Chicago, The University of Michigan, Stanford University and the University of Toronto. CDC 6000-7000 installations include Lawrence Radiation Laboratory, Northwestern University, Purdue University and the University of Texas. Other participants include Yale University (PDP-10), The University of Kansas (Honeywell 635), The University of Wisconsin (UNIVAC 1108) and a group of six British users of the ICL 1906-A.

It is hoped that the codes will attract attention from both numerical analysts and scientific users. Representatives from the participating institutions will meet periodically to share experience and provide feedback from the testing.

The Argonne center will begin distributing certified codes early in 1972. Response to users' problems and exchange of information on experience and performance will be coordinated through the center. A year of prototype operation of the center will help determine the value of thoroughly tested programs to scientific computer users and the future direction of such efforts.

Further information, including the procedure for obtaining the codes, can be obtained from NATS Project, Applied Mathematics Division, Argonne National Laboratory, Argonne, Illinois 60439.
A PROBLEM

Consider the following Fortran program:

\[
\begin{align*}
H &= 1.0/2.0 \\
X &= 2.0/3.0 - H \\
Y &= 3.0/5.0 - H \\
E &= (X + X + X) - H \\
F &= (Y + Y + Y + Y + Y) - H \\
Q &= 2.0*F/E \\
\end{align*}
\]

PRINT, Q

The variable \( Q \) can take on one of just seven values on any computer with hardware floating point arithmetic manufactured in North America, no matter what the radix, word length or rounding strategy. What are these values?

-- W. Kahan
University of California
Berkeley

W. E. MILNE

William Edmond Milne died on January 19, 1971. He was professor emeritus and formerly head of the mathematics department at Oregon State University. Professor Milne is well known for his early work in numerical analysis and particularly for a widely used textbook and a method for the numerical solution of ordinary differential equations.

NRC FELLOWSHIP BROCHURE

The Division of Mathematical Sciences of the National Research Council has announced that its annual brochure on Fellowship and Research Opportunities in the mathematical sciences is available. Copies may be obtained from the Council at 2101 Constitution Ave., N. W., Washington, D. C. 20418.
A new Fortran library of elementary functions has been in use since the fall of 1970 on the UNIVAC 1108 computer (Library release RLIB$55). Considerable effort has been expended by Univac to produce a library of functions that are consistently accurate and yet efficient.

Extensive accuracy testing was accomplished by using thousands of arguments (assumed to be error-free) over all possible ranges emphasizing known problem intervals. This helped ensure that any accuracy deterioration occurring through function calculation would be detected. The function results were then compared with higher-precision function results for final analysis. For single precision and complex functions, it was found that a phenomenal 97 percent of the function values were exact. Not only were errors seldom encountered, but they were always confined to the least significant (27th) bit position.

For the 1108, the single precision, real part of the complex and imaginary part of the complex formats have a 27 bit mantissa length. Double precision format has a 60 bit mantissa length. Although test results for the double precision functions were not as spectacular, the results indicated error occurring for only about 45 percent of the arguments tested. Also, the error was always confined to the four least significant bits of the function results.

Efficiency was maintained in the new library despite the heavy impact of accuracy demands. An overall increase was experienced of only about 12 percent over the low execution times of the old library. Such consistency of high accuracy from function to function in a set of fast routines is highly unusual if not completely unheard of heretofore.

Test programs used, except for the complex functions, were kindly provided by the Jet Propulsion Laboratory, Pasadena, California.

Further information is available in the Univac 1100 series program reference manual for the Fortran V library, number UP - 7876, and in a report entitled "Accuracy enhancement of the Fortran V math library" by Thomas H. Miller, available from Univac Product Development, Salt Lake City, Utah.
IMSL's Ideas on Subroutine Library Problems

by

O. G. Johnson
Executive Vice President, IMSL

Those who are interested in subroutine libraries will remember 1970 as the year in which libraries of this type became commercial. Before unbundling the fruits of such endeavors were essentially free for the asking. However, in 1970 there were at least three major developments in the commercial sector. First, IBM announced a PL1 math library, PL-MATH, at $100 per month rental. The same year, CDC obtained an extensive FORTRAN library from Boeing which it now markets at $450 per month with a $450 initial charge. Finally, in 1970, IMSL, International Mathematical & Statistical Libraries, was incorporated with the intent of producing all kinds of math-stat libraries in all kinds of languages for all kinds of machines. Its first product, IMSL Library 1, is in FORTRAN for the IBM/370-360 series and leases for $720.00 per year.

Why should a small company like IMSL pitch its hat into the ring against IBM and CDC? Also, the universities and research centers are still producing. Can IMSL stand the competition?

Only time will tell whether or not the IMSL approach is a good one. Those of us at IMSL feel that our approach is the only sound solution to a number of problems which have plagued subroutine library development. Here are six such problems along with IMSL's approach to each.

The Problem of Confederacy
An early problem in the field of subroutine libraries was manifested by the SHARE library. A product of loose knit confederacy, it suffered from lack of general direction and uniformity. Catch-as-catch-can endeavors result in 100 programs to transpose a matrix and none to perform spline smoothing. The variance in quantity is also matched by a variance in quality. No central attempt is usually made to separate the wheat from the chaff.

IMSL's solution to this problem has been to divide the field of math-stat computations into chapters; to identify at least one expert in each chapter; to contract his services and to ask him what routines should be in that chapter and what sources are available for these routines.
IMSL, in turn, sees to it that each chapter makes full use of every other chapter and that all routines in all chapters are coded in a uniform manner. IMSL's manual of coding conventions, which each IMSL programmer is required to follow rigidly, is over thirty pages long, and delimits variance between programmers.

**The Problem of Internalism**

SSP was written with the assumption that all the knowledge for producing such a product existed in IBM's program development department. Stuart Lynn and Bill Timlake, then at IBM's Scientific Center in Houston, attempted in vain to convince IBM that outside experts should be consulted. Finally, after extensive effort, IBM agreed to hire one consultant for its PLi product - PL Math and to move the programming group for this product to Houston for interaction with the Scientific Center there. All of this, of course came too late to help SSP, which in its third version was still hopelessly dated from the outset.

IMSL's consultant advisory board consists of nine of the foremost names in numerical analysis, statistics, and library construction. IMSL plans to expand its advisory board as needs dictate.

**The Problem of Specialization**

Numerical analysts who venture into the engineering or statistical literature are often shocked to find out how little they are influencing scientific programming. Most engineers and statisticians do not inquire into the relevancy of numerical advances for their applications. I recently discovered that the state of Texas had spent an amount well into six figures for a civil engineering company to program a linear parabolic diffusion model of pollutants in Galveston Bay. The resulting program used Euler's method.

BMD is the classical example of a statistical package sans numerical savoir faire.

In order to try to avoid this problem, IMSL's full time staff consists of Ph.D's in statistics, numerical analysis, and engineering. These people work together. In addition, its advisory board represents a diversity of backgrounds.

**The Problem of Quality**

Subroutine libraries are destined to live with the quality-quantity dilemma. If standards are very high, one produces few if any routines. Further, if one belabors a given routine too long, one runs the risk of algorithmic, software, or hardware obsolescence.
While IMSL strongly encourages the development of high quality software at research institutions, only the final results are of commercial value. Indeed, if the commercial concern bears the brunt of development cost on a large scale, there is no possibility of profit.

The IMSL concept of yearly editions is the only commercially feasible solution to the quality problem. Edition 1 of a library should be good enough to easily justify its cost; however, it may not be uniformly state-of-the-art. Edition 2 must represent a non-trivial improvement (probably at an increased cost to new subscribers.) New public domain advances should be modified to conventions and inserted in the library. Also, profits permitting, special study contracts should be let in selected areas where development costs are not excessive. Editions 3, 4, ... iterate toward perfection. SSP had versions I, II, and III. If the increments had been larger, the consulting more extensive, and if by now we had version VI or VII in the correct FORTRAN language, there would have been little need for IMSL Library 1.

The Problem of Documentation
Academicians do not always appreciate the fact that a subroutine can be over documented as well as under documented. Having used so many underdocumented and misdocumented programs, there is a natural tendency to try too hard to be absolutely clear. Programmers in industrial environments are discouraged by weighty documentation. They often feel that the effort required to understand the program documentation is more than they are willing to invest.

The IMSL solution to this problem is telephone consultation. We make the written documentation concise for easy use. If problems arise the user can call us. Its part of the service we render. It is both cheaper and better for the user. He does not have to wade through pages of useless documentation for a simple, quick, textbook problem nor is he at a loss for information on harder problems. Of course only an organization with a full time commitment can offer verbal as well as written documentation.

The Problem of Propriety
As a final note, I would like to mention that any advice given to IMSL by any member of its advisory board is non-proprietary in the sense that the advisor may give the same advice or program listing, or algorithm to any other concern. Unlike other software companies, we do not ask or even want the techniques and tricks-of-the-trade given us through consultation to be our property only. Commercial subroutine libraries should not obstruct the normal channels of scientific interchange.