PROJECTS and PUBLICATIONS
of the
APPLIED MATHEMATICS DIVISION
A Semi-Annual Report
January through June 1968
NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards1 was established by an act of Congress March 3, 1901. Today, in addition to serving as the Nation's central measurement laboratory, the Bureau is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. To this end the Bureau conducts research and provides central national services in three broad program areas and provides central national services in a fourth. These are: (1) basic measurements and standards, (2) materials measurements and standards, (3) technological measurements and standards, and (4) transfer of technology.

The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, and the Center for Radiation Research.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement, coordinates that system with the measurement systems of other nations, and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of an Office of Standard Reference Data and a group of divisions organized by the following areas of science and engineering:


THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to methods, standards of measurement, and data needed by industry, commerce, educational institutions, and government. The Institute also provides advisory and research services to other government agencies. The Institute consists of an Office of Standard Reference Materials and a group of divisions organized by the following areas of materials research:


THE INSTITUTE FOR APPLIED TECHNOLOGY provides for the creation of appropriate opportunities for the use and application of technology within the Federal Government and within the civilian sector of American industry. The primary functions of the Institute may be broadly classified as programs relating to technological measurements and standards and techniques for the transfer of technology. The Institute consists of a Clearinghouse for Scientific and Technical Information,6 a Center for Computer Sciences and Technology, and a group of technical divisions and offices organized by the following fields of technology:


THE CENTER FOR RADIATION RESEARCH engages in research, measurement, and application of radiation to the solution of Bureau mission problems and the problems of other agencies and institutions. The Center for Radiation Research consists of the following divisions:


1 Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D. C. 20234.
2 Located at Boulder, Colorado 80302.
3 Located at 5285 Port Royal Road, Springfield, Virginia 22151.
PROJECTS and PUBLICATIONS
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APPLIED MATHEMATICS DIVISION FUNCTIONS

Conduct research and provide consulting services to the Bureau and other Federal agencies in various fields of mathematics important to physical and engineering sciences, automatic data processing, and operations research with emphasis on statistical, numerical and combinatorial analysis, and mathematical physics. Develop tools for mathematical work such as mathematical tables, handbooks, manuals, mathematical models and computational methods, and advise on their use. Provide training in disciplines related to these functions.

NUMERICAL ANALYSIS SECTION: The advancement of computation and the theory of numerical analysis, particularly in the development of computing algorithms, approximations to functions, and methods to facilitate the use of high speed electronic computers by subject matter specialists. Design of mathematical tables; exploratory calculations on automatic machines. Consulting services and training, and preparation of manuals in these fields. Research in underlying branches of pure and applied mathematics, such as matrix algebra, combinatorial analysis, and number theory.

OPERATIONS RESEARCH SECTION: Development and application of mathematical and computational techniques for the analysis, improvement or optimization of complex systems or activity-patterns. This includes (1) research in specific relevant areas of mathematics, such as linear programming, the theory of linear graphs, and the theory of strategic contests, (2) investigations in the art of constructing useful mathematical models of complex systems, and of obtaining information about the system by applying analytic or simulation methods, and (3) application of these techniques to selected problems of general methodological significance, arising in the work of the Bureau or of other Government agencies lacking specialized personnel in this field.

STATISTICAL ENGINEERING SECTION: Consulting services in the application of mathematical statistics to physical science experiments and engineering tests, particularly in the design of experiments and in the analysis and interpretation of data. Research on pertinent topics in probability and mathematical statistics. Preparation of reports, manuals, tables, studies of computational methods and other aids to the application of modern statistical methods.

SYSTEMS DYNAMICS SECTION: Research and consulting in applied mathematics basic to physics and engineering, with emphasis on analysis of the dynamic behavior of complex physical systems. This involves, primarily, the development and application of techniques for solving linear and non-linear systems of differential equations and integral equations, or combinations of both. Of concern also is simulation of the behavior of physical systems by means of electronic computers using approximation techniques and semi-analytic methods. Attention is given to problems in plasma dynamics and the behavior of solid matter and multicomponent liquid systems, with emphasis on developing mathematical methods of wide range of applicability beyond the scope of the immediate problem. Investigations are carried out on the special functions encountered in the analysis and algorithms for their evaluation are prepared.
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*Only unclassified material is included in this report.
APPLIED MATHEMATICS DIVISION

January 1 through June 30, 1968

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Philip Meyers, Ph.D.*
Martin H. Pearl, Ph.D.*
Patsy L. Saunders, B.S.

*Part-time
**Postdoctoral Resident Research Associate
***Guest Worker

°On Leave of Absence

ooooStudent Trainee
Status of Projects

1. NUMERICAL ANALYSIS

RESEARCH IN NUMERICAL ANALYSIS AND RELATED FIELDS

Task 20501-12-2050110/55-55

Origin: NBS
Manager: Morris Newman
Full task description: July - September 1954 issue, p. 1

Status: CONTINUED. M. Newman and R. Brualdi have shown that the number of formally distinct terms in the permanent of an \( n \times n \) circulant is given by

\[
\frac{1}{n} \sum_{d \mid n} \varphi \left( \frac{2d-1}{d} \right) \varphi(n/d),
\]

where \( \varphi \) is the Euler function.

M. Newman and J. Lehner have given a great number of identities for sums of the form

\[
\sum f(k,k'),
\]

where \( k,k' \) run over all consecutive pairs of denominators of the Farey fractions of order \( n \). For example,

\[
\sum \frac{1}{k+k'} = \frac{6}{n^2} (2\log 2 - 1)n + O(\log n)^2,
\]

\[
\sum \sqrt{kk} = \frac{32 - 3\pi}{12n^2} n^3 + O(n^3 \log n).
\]

M. Newman has proved that for every positive \( r \), the fundamental region of the principal congruence subgroup \( \Gamma(n) \) of the modular group \( \Gamma \) consists of arcs of circles of radii \( \geq 1/r \), where \( r \leq n^{2+\varepsilon} \).

M. Newman, I. Stegun, and R. Zucker have prepared FORTRAN versions of the program to solve equations exactly. M. Newman's version will produce the exact solution of any non-singular system of 100 equations or less in which the coefficients are arbitrary integers numerically less than \( 10^{10} \), or the exact solution of any non-singular system of 50 equations or less in which the coefficients are arbitrary integers numerically less than \( 10^{20} \). The running time on the Univac 1108 averages 1 minute for a 40 x 40 system, but can go as high as 6 minutes for such a system.

K. Goldberg has continued his investigation of the coefficients of the powers of iterates of formal power series. He has related this problem to one involving the powers of linear differential operators.
Status of Projects

S. Haber proved the existence of stochastic quadrature formulas for 5-dimensional cubes, of all degrees of precision. He also constructed some equal-coefficients stochastic formulas of degree 3 for cubes.

S. Haber and C.F. Osgood investigated some problems associated with the number-theoretic methods of numerically evaluating multiple integrals due to N.M. Korobov and E. Hlawka. They showed that certain diophantine estimates used in this theory were best possible; this implied that the best error estimates known in the 2-dimensional case were not obtainable from Korobov's general theory. They also proved various theorems on the existence or non-existence of quadrature formulas of certain types for some classes of periodic functions.

S. Haber began a program of calculations designed to clarify the properties of Korobov's quadrature formulas. The ultimate objective is to find the best formulas of this class, together with error bounds for them. This can be done directly only for formulas using relatively few—up to about 1,000—points. Programs to do this were written and checked out, and used to calculate some best formulas using 101 or fewer points. Calculations will be continued at the University of Maryland, due to unavailability of time on the NBS computer.

Formulas which are "best" relative to a certain subclass of all Korobov-type formulas were previously calculated by Saltykov, in Russia, Saltykov's calculations were extended, and somewhat improved; and the results compared to the best formulas mentioned above.

F.W.J. Olver has completed an error analysis of the Laplace method for determining asymptotic expansions of definite integrals. Applications have been made to Bessel, gamma and other special functions, and new error bounds have been computed.

Publications:


(6) On the sum $\sum <\alpha_n>_t$. S. Haber and C.F. Osgood. Submitted to a technical journal.


Status of Projects


2. PROBABILITY AND MATHEMATICAL STATISTICS

RESEARCH IN PROBABILITY AND MATHEMATICAL STATISTICS

Task 20503-12-2050131/63-1259

Origin: NBS
Manager: Joan Raup Rosenblatt
Full task description: July - December 1962


Professor Clatworthy (State University of New York, Buffalo) will be in charge of the work. The project is a joint effort involving the Bureau, and the University of North Carolina.

Joan R. Rosenblatt has obtained preliminary results in an investigation of the effect on analysis of straight line data of a "cumulative error" component of variance in addition to the "measurement error" variance. The model studied is

\[ Y_{i+1} - Y_i = \beta(x_{i+1} - x_i) + e_{i+1} + (d_{i+1} - d_i), \]

\[ i = 1, ..., n-1, \] where \( \beta \) and the \( x_i \) are fixed constants (\( \beta \) unknown) and the \( e_i \) and \( d_i \) are mutually independent random variables with zero means and variances \( (t_i - t_{i-1}) \sigma_e^2, \sigma_d^2 \), respectively.

John Mandel (J. Amer. Statist. Assoc., 1957) defined the two extreme cases, Model A (\( \sigma_e^2 = 0 \)) and Model B (\( \sigma_d^2 = 0 \)) and investigated the properties under Model A(B) of statistical procedures appropriate for B(A). The new results include Mandel's results as extreme cases. Estimates of the variance components \( \sigma_e^2 \) and \( \sigma_d^2 \) are studied.

H. H. Ku and S. Kullback (George Washington University) have applied the procedure of minimum discrimination information estimation to five examples of contingency table analysis given by Joseph Berkson in his paper in Biometrics, Vol. 24, No. 1, 1968. The results are compared with those given by Grizzle using maximum likelihood and those given by Berkson using minimum logit \( \chi^2 \).

Publications:


(3) The distribution of the sample variance from a two-point binomial population. D. Hogben. Submitted to a technical journal.

(4) For samples of size 3 from a normal distribution the range and the mean deviation have the same distribution except for a scale factor. B. L. Joiner and J. R. Rosenblatt. Submitted to a technical journal.

(5) A guide to commonly used terms and expressions of imprecision, systematic error, and uncertainty associated with a reported value. H. H. Ku. To appear in Measurement and Data.

(6) Analysis of information--An alternative approach to the detection of a correlation between the sexes of adjacent sibs in human families. H. H. Ku. Submitted to a technical journal.

3. STATISTICAL ENGINEERING SERVICES

COLLABORATION ON STATISTICAL ASPECTS OF

NBS RESEARCH AND TESTING

Task 13911-61-2050950/51-1

Origin: NBS

Authorized 7/1/50

Managers: J. M. Cameron, H. H. Ku

Full task description: July - September 1950 issue, p. 60

Status: CONTINUED. This is a continuing project involving cooperation with other Bureau scientists on the statistical aspects of their investigations. These services vary from short (one-hour) sessions to extended collaborations involving several man-months; and are concerned primarily with statistical design of experiments, analysis and interpretation of data, and the use of computers in statistical analysis of data. Typical examples of the services performed are the following.

A series of 15 seminars emphasizing the application of statistical techniques in the design, analysis and interpretation of scientific data was conducted. As a result of collaboration with members of the Analytical Chemistry Division, the value of such a series was recognized by B. L. Joiner, who presented many of the lectures and arranged for talks by other members of the Bureau staff. Details of the topics covered will be found below under "Lectures and Technical Meetings." Average attendance during the series was about 50, with participation from many Bureau divisions.

Two members of the staff were invited to present lectures as part of Seminars sponsored by Bureau calibration laboratories. H. H. Ku talked on "Statistics in Counting" in the Precision Measurement Seminar on Radiation Quantities. J. M. Cameron participated in the Precision Measurement Seminar on Length Measurements.

Janace A. Speckman collaborated with C. S. McCamy and S. R. Wiley (Image Optics and Photography Section) in preparation of a paper reporting results of a survey of blemishes on processed microfilm. Descriptions of blemishes had been obtained by microscopic inspection of 741/2 rolls of film and were analyzed in conjunction with data on the processing and storage histories of the film.

Publications:

Status: CONTINUED. This is a continuing project which involves providing, upon request, statistical services to other governmental agencies, universities, industrial organizations, and other non-governmental agencies. Approximately 30 such requests are handled per month ranging from short conferences to collaboration involving several days work.

A four-day Seminar on Precision and Accuracy in Measurement and Calibration was presented to metrologists from 23 industrial and 10 governmental laboratories. The Seminar dealt with the concepts of a National Measurement System as presented by Dr. Shirleigh Silverman, Associate Director for Academic Liaison, and of the need for viewing measurement as a production process. These concepts were developed in presentations by Churchill Eisenhart, NBS Senior Research Fellow and in talks by Paul E. Pontius of the Mass and Volume Section and J. M. Cameron of the Statistical Engineering Laboratory.

Lectures were presented on Propagation of error in a chain of laboratories (by Joan R. Rosenblatt), Calibration curves (by David Hogben), Accuracy ratios (by H. H. Ku), Design of experiments and interlaboratory comparisons (by J. M. Cameron) and Control chart techniques (by B. L. Joiner).

The participation of personnel from Bureau laboratories apart from the Statistical Engineering Laboratory added considerably to the value of the program. Woodward G. Eicke of the Electrochemistry section presented some new methods for intercomparing groups of voltage standards and maintaining surveillance over the measurement process involved. Robert C. Raybold of the Mass and Volume section presented an account of measurement problems in photometry and steps in the evaluation of process parameters. Dr. Henry J. Kostkowski, of the Radiation Thermometry Laboratory presented material on the accuracy of temperature measurements, and Thomas L. Zapf of the Radio Standards Laboratory in Boulder discussed problems in radio frequency measurements.

J. M. Cameron participated in a joint Army-Navy-Air Force task group on electrical measurements held at Newark APS, Ohio. As a result of the meeting collaboration between Norman Beleoki of Newark APS, Robert McCallum, Sandia Corporation and W. G. Eicke of the Electrochemistry section of NBS was begun to extend the ideas of the PILOT program (interlaboratory collaboration to establish performance characteristics of measurement processes) in mass voltage measurements.

Joan R. Rosenblatt assisted the staff of a Presidential Task Force on Communications by using the OMNITAB program to prepare a variety of tables and least squares computations.
4. MATHEMATICAL PHYSICS

RESEARCH IN MATHEMATICAL PHYSICS
AND RELATED FIELDS

Task 20540-12-2050141/55-57

Origin: NBS
Manager: H. J. Oser
Full task description: July-September 1954 issue, p. 27

Authorized 9/1/54

In collaboration with Dr. R. deWit of the Lattice Defects and Microstructure Section (312.03), J. T. Fong continued to investigate the geometric foundation of several continuum theories of dislocations such as those of Kondo (1952), Bilby, Boulough and Smith (1955), Kroner (1955-60) and deWit (1967), with the goal of unifying them by means of three basic notions in Riemannian calculus, namely, the definition of a covariant basis, the notion of a point transformation in a geometric manifold, and the associated concept of the dragging along a coordinate system. The first notion enables one to deduce the basic geometric equations in each theory by appealing to the theory of a totally integrable system of first order partial differential equations. Based on the remaining two notions, the concept of a Lie derivative representing the time rate of change of an object field with respect to a contravariant velocity vector field for infinitesimal deformations is shown to be the natural tool for the study of motions in a continuum of distributed dislocations.

A talk entitled "On the application of dislocation theory to engineering problems" was given by Dr. Fong, February 19, 1968 at the Westinghouse Research Laboratories Lecture Series in Mechanics of Materials, Westinghouse Electric Corporation, Churchill Borough, Pittsburg, Pa.

Dr. George B. DeLancey joined the then Mathematics Physics Section under a Postdoctoral Research Associateship on November 22, 1967. Dr. DeLancey has focused his primary attention on the numerical solution of coupled heat and mass transfer problems with nonlinear reaction kinetics. The flux expressions are based on the postulates of irreversible thermodynamics.

A scheme for integrating the diffusional contribution to the transfer process has been developed which permits the use of a maximum time step in each of the coupled equations. Each time step depends upon the associated eigenvalue in the transport coefficient matrix. Work is continuing on (i) an appropriate mesh configuration in spherical coordinates to account for the singular coefficient in the transport equations at the origin; (ii) accurate approximations for the reaction velocities.

The theoretical assumptions associated with existing and new techniques for measuring cross diffusion coefficients in both isothermal and nonisothermal systems are being investigated.

A paper entitled "An Analysis of Nonisothermal Multicomponent Mass Transfer" was presented by Dr. DeLancey at the meeting of the American Institute of Chemical Engineers in Tampa, Florida. Open seminars based on this presentation were conducted within the Systems Dynamics Section.

Publications


(4) A manuscript entitled "On the coupling of longitudinal and transverse waves in a linear three-element viscoelastic string subjected to transverse impact," by Dr. J. T. Fong with co-author J. C. Smith of the Polymer Interface Section (311.07) has been accepted for publication by the J. of Research NBS (B: Mathematics and Mathematical Physics).
PLASMA RESEARCH

Task 20504-12-2050140/59-442

Authorized 10/31/61

Origin: NBS
Manager: H. J. Oser

Full task description: October-December 1961 issue, p. 12

Status: CONTINUED. Dr. W. L. Sadowski and Mrs. Z. G. Ruthberg examined the problem of truncation in Fourier-Hermite space of the solution of the non-linear Vlasov equation. The approach led to a combinatorial study of a two-term non-linear differential operator. A manuscript on the general properties of such an operator is in preparation. This combinatorial problem has also been studied on the computer with the aid of the LISP language in cooperation with Mrs. E. Fong (System Research and Development Division). Specific application of the combinatorial technique to the Vlasov operator has been studied. The problem is at the point where FORTRAN programming is feasible and will be carried out.

A study of the application of rational function approximations to the eigenfunction has been initiated. This work is in progress.

A study of the properties of the Hermite expansion for the two-stream problem has been completed. Temperature renormalization has been examined and found not to have significant effect on numerical stability for the values of the non-linearity parameters studied so far. It will, however, be significant in the future for higher values of non-linearity. A manuscript on the work is in preparation.
5. OPERATIONS RESEARCH

CONSULTATION IN MATHEMATICAL OPERATIONS RESEARCH

Task 205-12-2050151

Origin and Sponsor: NBS
Manager: Alan J. Goldman
Full task description: October-December 1960 issue, p.3

Authorized 12/30/60

Status: CONTINUED.

(1) Demand for miscellaneous consulting and advisory services continued heavy. Section staff provided such services in 80 recorded instances; of these 47 involved assistance to NBS staff, covering 7 NBS divisions or other subunits. The 80 instances totalled to 635 recorded man-hours. Other agencies assisted included National Institutes of Health, Atomic Energy Commission, Bureau of Public Roads, U.S. Information Agency, Agency for International Development, and the Bureau of Prisons. Requests from universities, industries, professional groups and journals were also met.

(2) J. Gilsinn, W. Horn and A.J. Goldman continued assistance in a study to determine locations and sizings for inland marine cargo consolidation centers. Goldman and L.S. Joel continued assistance to the Department of Housing and Urban Development in connection with systems analyses of urban transport. (Reported here for convenience; supported under Projects 4314422 and 2056025 respectively.)

(3) W.G. Hall continued assistance in developing a simulation model for a highway maintenance depot. He also continued helping the Army Date Field Systems Command in planning, design and numerical-analysis aspects of proposed new tactical artillery-fire control system. He initiated assistance to the National Highway Safety Bureau in planning and evaluating the data-systems elements of its activities. (Reported here for convenience; supported under Projects 4565425 and 2056025 respectively.)

(4) P.R. Meyers continued the study of "contractification" of self-mappings of metric spaces by remetrization, obtaining conditions for the simultaneous contractification of a finite family of commuting maps. A.J. Goldman investigated what probability distributions, of inputs per period to a "unitization" facility, would yield a time-invariant distribution for the fractional residues per period.

Publications


(3) W.A. Horn. Some fixed point theorems for compact maps and flows in Banach spaces. Submitted to a technical journal.

(4) P.R. Meyers. Contractive semigroups and uniform asymptotic stability. Submitted to a technical journal.

COMBINATORIAL METHODS

Task 205-12-2050152

Origin and Sponsor: NBS
Manager: Jack Edmonds
Full task description: October-December 1964 issue, p. 3; April-June 1962 issue, p.15

Authorized 12/30/60

Status: CONTINUED.

J. Edmonds wrote a draft of "A labeling method for maximum network flows which is bounded by a polynomial in the number of nodes" and together with R. Karp of IBM, developed other improvements in network flow methods. He rewrote "Matroids and the greedy algorithm" for publication in the proceedings of the recent Mathematical Programming Symposium. He lectured on "Topics in combinatorics and optimization" at the 3rd Waterloo Combinatorics Conference. He continued various studies on matroids, lattices, polyhedra, subisomorphisms and combinatorial algorithms.
LINEAR AND NON-LINEAR PROGRAMMING

Task 205-12-2050153

A.J. Goldman and P.R. Meyers continued studies on the minimax error selection of incompletely specified discrete probability distributions, with "error" given by the L1 norm. For univariate distributions, two manuscripts were prepared dealing respectively with (a) componentwise bounds and (b) rank ordering as the "incomplete specification". As a by-product, Goldman solved the problem of choosing a non-negative matrix \((x_{ij})\), with prescribed row and column sums, to minimize \(\max_{i,j} x_{ij}\).

Publications

(1) A.J. Goldman. The minimax transportation problem. To appear in Transportation Science (Letters to Editor).

MATHEMATICAL METHODS FOR HIGH SPEED GROUND TRANSPORTATION STUDY

Task 205-12-205845b

(1) J. Gilsinn, A.J. Goldman and W.A. Horn prepared roughly 25 memoranda on various phases of the Northeast Corridor Transportation Project, including reviews of several contractors' reports.

(2) P. Saunders is carrying out conversion and adaptation of MIT scheduling research for application to high-speed trains in the Corridor, including (a) extension of the methods to cover 2 classes of service (local and express) and (b) integration of the algorithms with the demand forecasting models used elsewhere in the Project.

(3) C. Witzgall (with J. Gilsinn) completed a classification survey of labelling methods for shortest-path problems, including flow-charts for over 20 variants. J. Gilsinn is carrying out computational experiments aimed at comparing the performances of several of these algorithms on several types of networks.

(4) J. Levy and M.H. Pearl continued the development of methods for evaluating feedback vs. non-feedback methods for regulating flow at a merge point in a transport network. Several working papers on this subject have been prepared.
A.J. Goldman (with R. Ku of the NBS Technical Analysis Division) performed logical analyses and numerical experiments with variants of several demand forecasting models prepared by contractors. Considerable progress was achieved in obtaining improved model versions. Computational simplifications for other models were determined. An analysis was made of a "consumers' surplus" approach to evaluating user benefits from transport improvements. L.S. Joel is serving as technical monitor on another demand modelling contract.

Publications


Status: CONTINUED. During this period the Q32 computer at Systems Development Corporation has become our main research tool giving us the experience to help in the planning and design of other systems. Thus, the planning for the image processing facility at the Division of Computer Research and Technology at NIH has been largely influenced by the kind of image processing that we have been doing on the Q32 in LISP. The LISP implementation on the Q32 does not provide any special image processing facilities but rather general-purpose list structure manipulation capabilities. Consequently we added to this LISP system several functions using the assembler LAP to provide basic image processing capabilities at an efficiency greater than that provided by the LISP language. All of these functions are embedded in LISP and hence usable as ordinary LISP functions. The basic programs written include:

a. A program for computing arbitrary Boolean functions of two binary image planes.

b. A program for computing an arbitrary Boolean function of every point in a single binary plane expressed as a function of arbitrary neighbors of that point.

c. A function for counting neighborhood points of each point in a plane and thresholding the resultant counts.

d. A program for shifting a plane by a specified x and y.

e. A program for isolating an arbitrary set of connected points in a plane, hence for selecting out continuous connected objects or blobs.

Using the basic functions, high level functions were written in LISP that enabled us to get density histograms of discrete objects in pictures, programs that enabled us to experiment with various types of binary threshold operations on the multiple level pictures, and programs to select arbitrary sections of images for printing display on the Teletype printer. These programs were used in conjunction with inputs on magnetic tape that contained complete scans for a piece of cortex tissue.

Since there was no LISP available locally at NBS a small interpreter was written for the 1108 Univac to enable LISP programs to be run. This interpreter is presently not complete, although most programs not involving numerical computation can be run.

Plans are in the final stages for the connection of a galvanometer scanner for the Linc-PDP-6 computer in Dr. Lipkin's laboratory. Preliminary investigation of the scanner and suitability of connecting it to the machine has been completed as well as has some design on the actual interconnection hardware. During the coming fiscal year this will provide a major tool in scanning images directly through the microscope with programmable light sources as well as microscope and stage control. Since the images to be produced will be available in magnetic tape form, all the image processing capabilities developed on the Q32 computer can be devoted to the processing of these microscope images.

Hardware was designed and constructed for the connection of an NIH microspectrophotometer with controlled monochromator light source for connection to a Linc-PDP-6 computer. When this connection is complete the microspectrophotometer will be under the complete control of the computer with direct readings obtainable through analog to digital conversion hardware in the computer.
Mathematical Tables

Task 20500-40-2050121/57-216

Origin and Sponsor: NBS
Manager: I. A. Stegun
Full task description: July-December 1964 issue, p.4

Status: CONTINUED. A correction list and updating bibliographic material are continually being maintained for all published volumes. Errata are corrected in subsequent printings. A correction list was submitted for a seventh printing of AMS 55- the Handbook of Mathematical Functions.

Assistance in the evaluation or modification of computing techniques, identification of functions and their tabulation continued at the rate of about 10 consultations per month to NBS divisions, other government agencies, industry and universities.

In the course of examination of computing algorithms for special functions, R. Zucker discovered various pitfalls and inefficiencies in the 1108 FORTRAN library subroutines. For example, there was no extension of the range of argument in the double precision subroutine for the hyperbolic sine and cosine. The tangent subroutine involved both the sine and cosine subroutines - in each of which the angle is reduced to the first octant and then a seventh or eighth degree polynomial evaluated.
Lectures and Technical Meetings

Seminar on Statistics for Chemists and Physicists

JOINER, B. L.  
The utilization of basic statistical methods in the interpretation of data. January 17.

JOINER, B. L.  

KU, H. H.  

EISENHART, C.  

JOINER, B. L.  
Basic considerations in the planning of experiments. February 21.

JOINER, B. L.  
The use of control charts in checking measurement stability. February 28.

JOINER, B. L.  
Functional relationships fitted to data by the method of least squares. March 6.

JOINER, B. L.  

KU, H. H.  

JOINER, B. L.  
Basic distributions: Gaussian, Student's t, F, etc. March 27.

MANDEL, J.  
(Office of the Director, Institute for Materials Research). The analysis of data in the evaluation of materials and instruments. April 3.

MANDEL, J.  
(Office of the Director, IMR). The analysis of data in the evaluation of materials and instruments, continued. April 10.

JOINER, B. L.  
Some problems arising in testing for homogeneity of materials. May 1.

ROSENBHATT, J. R.  
Some techniques that do not depend on the assumption of normality. May 8.

MANDEL, J.  
(Office of the Director, IMR). The conduct and analysis of interlaboratory studies and the role of standard reference materials. May 15.

Mathematics Division Expository Seminar

NEWMAN, M.  
How to approximate numbers. February 28.

OLVER, F. W. J.  
Numerical use of recurrence relations. March 27.

KU, H. H.  
The analysis of categorical data in cross tabulations. May 1.

KIRSCH, R. A.  
Theoretical limitations of computers and some practical consequences. May 22.

GOLDMAN, A. J.  

Applied Mathematics Division Lectures

SHISHA, Dr. Oved  

LOUBALL, P.  
(University of California at Berkeley). A mathematical model for trip distribution. February 8.
HALL, W.
Analysis I. A beginning course in analytic geometry and calculus.

HOGBEN, D.
Introduction to mathematical and statistical analysis of laboratory data.

PEAVY, Sally T.
FORTRAN programming for beginners.

VARNER, Ruth N.
New topics in FORTRAN.

Papers and Invited Talks
Presented by Members of the Staff
at Meetings of Outside Organizations

DELANCEY, G. B.
An analysis of non-isothermal multicomponent mass transfer. American Institute of Chemical Engineers, Tampa, Fla., May 22.

EDMONDS, J.
A labeling method for maximum network flows which is bounded by a polynomial in the number of nodes. Mathematics Department, Princeton University, Princeton, N. J., February 20.

Topics in combinatorics and optimization. Third Waterloo Conference, Ontario, Canada, May 19-31.

FONG, J. T.
On the application of dislocation theory to engineering problems. Westinghouse Electric Corporation Research and Development Center, Pittsburgh, Pa., February 19.

GOLDSMITH, A. J.


HOGBEN, D.
OMNITAB for UNIVAC 1108. Social Security Administration, Baltimore, Md., February 29.

KU, H. H.
Contingency tables with fixed marginals. University of Maryland, College Park, Md., March 27.

OLVER, F. W. J.
The numerical solution of difference equations. Department of Mathematics, Geneva College, Beaver Falls, Pa., April 1.

ROSENBLATT, J. R.

Systems Dynamics Section Seminar

LIPPS, F. B.
(Geophysical Fluid Dynamics Laboratory, Environmental Science Services Administration.)
Numerical experiments in thermal convection. April 3.

RIMON, Y.
(Naval Ship Research and Development Center.)
Solution of the Navier-Stokes equation for incompressible flow over a disc or sphere. May 15.

LUOT, H. J.
(Naval Ship Research and Development Center.)
The final period of decay of arbitrary localized disturbances in a viscous fluid. June 19.
PUBLICATIONS ACTIVITIES

1.0 PUBLICATIONS THAT APPEARED DURING THIS PERIOD

1.3 Technical Papers


2.0 MANUSCRIPTS IN THE PROCESS OF PUBLICATION

2.2 Monograph


2.3 Technical Papers

Citation searching and bibliographic coupling with remote on-line computer access. F. L. Alt and R. A. Kirsch. To appear in the J. of Research NBS.


On the sum $\sum_{n=1}^{\infty}$. S. Haber and C. F. Osgood. Submitted to technical journal.

The distribution of the sample variance from a two-point binomial population. D. Hogben. Submitted to a technical journal.


Some fixed point theorems for compact maps and flows in Banach spaces. W. A. Horn. Submitted to a technical journal.

For sample of size 3 from a normal distribution the range and the mean deviation have the same distribution except for a scale factor. B. L. Joiner and J. R. Rosenblatt. Submitted to a technical journal.

A guide to commonly used terms and expressions of imprecision, systematic error, and uncertainty associated with a report value. H. H. Ku. To appear in Measurement and Data.

Analysis of information -- An alternative approach to the detection of a correlation between the sexes of adjacent sibs in human families. H. H. Ku. Submitted to a technical journal.

The problem of interaction in multidimensional contingency tables, an information theoretic approach. H. H. Ku. To appear in J. of Research NBS.

Contractive semigroups and uniform asymptotic stability. P. R. Meyers. Submitted to a technical journal.

Error bounds for the LaPlace approximation for definite integrals. F. W. J. Olver.

2.4 NOTES


NBS TECHNICAL PUBLICATIONS

PERIODICALS

JOURNAL OF RESEARCH reports National Bureau of Standards research and development in physics, mathematics, chemistry, and engineering. Comprehensive scientific papers give complete details of the work, including laboratory data, experimental procedures, and theoretical and mathematical analyses. Illustrated with photographs, drawings, and charts.

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TECHNICAL NEWS BULLETIN

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- **Handbooks.** Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

- **Special Publications.** Proceedings of NBS conferences, bibliographies, annual reports, wall charts, pamphlets, etc.

- **Monographs.** Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

- **National Standard Reference Data Series.** NSRDS provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated.

- **Product Standards.** Provide requirements for sizes, types, quality and methods for testing various industrial products. These standards are developed cooperatively with interested Government and industry groups and provide the basis for common understanding of product characteristics for both buyers and sellers. Their use is voluntary.

- **Technical Notes.** This series consists of communications and reports (covering both other agency and NBS-sponsored work) of limited or transitory interest.

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