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A COMPREHENSIVE GUIDE TO
INDUSTRIAL ENGINEERING COMPUTER SOFTWARE
AT FLORIDA TECHNOLOGICAL UNIVERSITY

BY

THOMAS OLIVER PEEPLES
B.S., Florida Technological University, 1972

RESEARCH REPORT

Submitted in partial fulfillment of the
requirements for the degree of Master of Science
in the Graduate Studies Program of
Florida Technological University

Orlando, Florida
1975

PREFACE

The purpose of this manual is to provide a guide to Florida Technological University Computer Center programs which are commonly used for Industrial Engineering analysis. The user need not have extensive prior knowledge of computers to use this manual but an adequate understanding of the applied engineering techniques is recommended.

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INTRODUCTION

Many different areas in Industrial Engineering require extensive analysis of large amounts of data. The programs included in this manual should satisfy most of the demands arising for the Industrial Engineering student at Florida Technological University.

This research project was prepared to satisfy the following objectives:

1. Provide an easy-to-use manual for both students and professors in the department of Industrial Engineering.
2. Provide a standardized method for documenting on-hand and to-be-acquired engineering software packages.

Each program performs a unique analysis which should be reviewed by the user as to its applicability. The programs are arranged in four categories:

1. Linear Programming
2. Simulation
3. Plant Management
4. Miscellaneous and General

An attempt has been made to gather together a variety of programs written by numerous users from a multitude of

locations. One of the major objectives has been to standardize this documenting effort. The documenting style arrived at is as follows:

- I. General Description (Provides the user with a brief overview of the program. Includes what it does, what the output includes, and any limitations.)
- II. Order of Cards in Input Deck (A brief mentioning of all cards to perform a minimum analysis using the program. The cards are enumerated upon in the sequence as required.)
- III. Card Preparation (A detailed description of cards mentioned above. They are referred to by the sequence initial from the above section.)
- IV. Additional Information (Includes problems that may be encountered and/or notes that may make program set-up easier.)
- V. References (A listing of manuals or sources where additional information may be acquired.)

An appendix has been included for those users not familiar with IBM360 System Control Language. Appendix A is an overview of all control cards necessary to gain access to Batch programs. Appendix B familiarizes the user with the procedures involved with Interactive Utilization. Appendix C contains some helpful hints if any errors should occur.

LINEAR PROGRAMMING

The programs in this chapter enable the user to perform a variety of computations of a linear programming nature.

LPGOGO is recommended to those with a straightforward problem definition, while PARAMET allows the varying of parameters to allow visualization of a dynamic system. TRANS is well-suited if mobility of supply and service is of interest. MPS/360 is only of use to those who desire to become deeply involved with an entire linear programming system as it is quite comprehensive and time-consuming to learn. LINPRO is effective if the user desires a minimal input and does not mind converting all constraints to inequalities. The problem involving integer programming should be run on ZONE or MINT. ZONE is applicable to the zero-one formulation while MINT will handle those of a mixed integer variety.

LPGOGO, LP

I. General Description

LP is an interactive version of LPGOGO. Both can handle up to 50 variables (including slack and surplus) and 25 constraints. Both use the two phase full tableau form of the simplex method and require all right hand sides to be non-negative. Since all constraints must be converted to equalities, the user must have a working knowledge of linear programming to be able to insert slack and surplus variables. With LP, multiple inputs are read free format and should be separated by spaces or commas. All zero entries must be entered.

II. Order of Cards in Input Deck

BATCH

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X,PROG=LPGOGO
- C. //SYSIN DD *
- D. Title Card
- E. Size Card
- F. Constraint Cards
- G. Variable Cards
- H. Constraint Coefficient Matrix
- I. Solve Card
- J. Blank Card
- K. //

INTERACTIVE

- A. LOGON (Appendix B)
- B. IRF4X LP
- C. *** LP INPUT ****
- D. LOGOFF

III. Card Preparation

BATCH

- D. Title Card
Col 1-80 Up to 80 character Title
- E. Size Card
Col 1-4 Number of Constraints, Right Justified (I4)
Col 5-8 Number of Variables, Right Justified (I4)
- F. Constraint Cards
Col 1-8 Constraint Name (A8)
Col 21-32 Right hand side value (F12.6)
Note: Repeat for each constraint
- G. Variable Cards
Col 11-19 Variable Name (A8)
Col 21-32 Objective Function Coefficient (F12.6)
Note: Only non-zero coefficients need be defined
- I. Solve Card
Col 1-5 Solve

INTERACTIVE

LP is completely self-documenting. Enter input as requested.

Note: To minimize, multiply objective function by (-1).

V. References

Daellenbach, Hans G. and Earl J. Bell. User's Guide to Linear Programming. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1970.

PARAMET

I. General Description

A. Parametric linear programming is the study of the behavior of the optimal solution to a linear programming problem as affected by a change or changes in the parameters of the original problem. This program uses the simplex algorithm and the parametric programming algorithm. The program handles these types of linear variation:

1. Variations in the objective factor coefficients
2. Variations in the right hand side
3. Simultaneous variations both of the above

B. Output Includes

1. Printout of the initial tableau
2. Printout of the simplex criterion
3. Printout of values of the objective function
4. Repeat of the above for each intermediate tableau, if requested
5. Printout of the initial solution
6. Printout of the value of the objective function before parameterization
7. Printout of 1 through 3 for each step in the parameterization (if requested)
8. Printout of the final optimal solution

C. Limitations

Up to 33 variables

II. Order of Cards in Input Deck

- A. //JOBCARD Class=A (Appendix A)
- B. // EXEC IRF4X,PROG=PARAMET
- C. //SYSIN DD *
- D. Constraint Definition
- E. User Print Options
- F. Objective Function

- | | |
|--|---|
| G. Coefficients of Variable Parameter | } May need more than one card for complete definition |
| H. Right Hand Side Variable Parameter | |
| I. Coefficients of Constraint Equation | |
| J. // | |

III. Card Preparation

- D. Constraint Definition
- | | | |
|-----------|--------------------------------|------|
| Col 1-6 | Number of Constraint Equations | (I6) |
| Col 7-12 | Columns +1 in Initial Tableau | (I6) |
| Col 13-18 | Real Variables +1 | (I6) |
- E. User Print Option
- | | |
|-------|---|
| Col 1 | 0=Print Optimal
1=Print all intermediates |
| Col 3 | 0= # parameters variation required
1=Objective function coefficient variations
2=Right hand side variations
3=Both 1 & 2 above |
- F. Objective Function Coefficients
- | | | |
|----------|--------------------|---------|
| Col 1-8 | First Coefficient | (F10.0) |
| Col 9-16 | Second Coefficient | |

.
.
.

Note: May be continued on additional cards.

- G. Coefficients of Variable Parameter
Same as F above
- H. Right Hand Side Variable Parameter
Same as F above
- I. Coefficient of Constraint Equation
Same as F above

V. References

Unknown

TRANS

I. General Description

TRANS (Transportation Program) is a linear programming program which handles those problems that are adaptable to a transportation model. It is of major interest in working with both the maximization and minimization of networks. It is vital that the total surpluses equal the total shortages.

II. Order of Cards in Input Deck

BATCH

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X, PROG=TRANS
- C. //SYSIN DD *
- D. Size Card
- E. Surpluses
- F. Shortages
- G. Costs
- H. Finish Card
- I. //

INTERACTIVE

- A. LOGON (Appendix B)
- B. IRF4X TRANS
- C. *** TRANS INPUT ***
- D. LOGOFF

III. Card Preparation

BATCH

- D. Size Card
of Surpluses, # of Shortages
- E. Surpluses
Enter surpluses separated by spaces or commas

- F. Shortages
Enter shortages separated by spaces or commas
- G. Costs
Enter unit shipping costs separated by spaces or commas
- H. Finish Card
1=Another problem
0=Finished

INTERACTIVE

- C. TRANS is completely self-documenting and input should be entered as requested.

V. References

Taha, Hamdy A. Operations Research, an Introduction. New York: MacMillan Publishing Co., Inc., 1971.

MPS/360

I. General Description

MPS/360 is an open-ended mathematical programming system. Use of MPS/360 might involve building a mathematical model, finding an optimal solution, determining the effect of changing key data on the optimal solution, computing alternate solutions by systematically varying cost or requirement data, and preparing a management report. This linear programming system is characterized by an increased control language flexibility, more sophisticated linear program capabilities, a separable programming feature, and a Fortran interface.

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC MPS360
- C. //CPC.SYSIN DD *
- D. ** MPS Program Control Statements ***
- E. /*
- F. //EXEC.SYSIN DD *
- G. *** Input Data to MPS/360 Procedures **
- H. //

III. Card Preparation

See References listed below

V. References

MPS/360 Control Language. New York: IBM Corp., 1970.

MPS/360 Linear and Separable Programming. New York: IBM Corp., 1970.

LINPRO

I. General Description

LINPRO is an interactive linear program with a maximum of 50 variables and 25 constraints. It can handle either maximization or minimization problems without negation of the objective function. All of the constraints must be inequalities which means converting equal constraints to a greater and a less than constraint. Input is format free and should be separated by spaces or commas.

II. Order of Cards in Input Deck

BATCH

- A. //JOB CARD Class=A (Appendix A)
- B. // EXEC IRF4X,PROG=LINPRO
- C. //SYSIN DD *
- D. Number of Variables
- E. Number of Constraints
- F. Maximize: Enter 0; Minimize: Enter 1
- G. }
- H. } Repeat for each constraint
- I. }
- J. Values of Variable Coefficients in Objective Function
- K. Finish Card
- L. //

INTERACTIVE

- A. ** LOGON ** (Appendix B)
- B. IRF4X LINPRO
- C. ** LINPRO Data as Asked For **
- D. LOGOFF

III. Card Preparation

BATCH

- G. Values of variable coefficients in constraint 1 must be separated by spaces or commas. Use as many cards as necessary. If variable does not exist, enter a zero.
- H. Constraint 1 sign. Enter 0 for \leq ; 1 for \geq .
- I. Value of constraint 1 constant
Note: Steps G, H, I are repeated for each constraint
- K. Finish Card
Yes if another run is desired; No if this is final run.

INTERACTIVE

Program is self-documenting as it is executing.

V. References

Unknown

ZONE (ZERO-ONE)

I. General Description

ZONE calculates the optimal solution to a zero-one problem using implicit enumeration. The program will handle up to 50 variables, but will only print results for 11. All objective function coefficients must be non-negative and the objective function itself must be minimized. All constraints must be of the form $G(I)$ greater than or equal to zero. Data is to be entered freefield format separated by spaces or commas.

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X,PROG=ZONE
- C. //SYSIN DD *
- D. Size Card
- E. Objective Function (May be repeated)
- F. Constraints (May be repeated)
- G. ZBAR Card
- H. 9999 Card
- I. //

III. Card Preparation

- D. Size Card
 Freefield: Number of Constraints
 Number of Variables
 Interval at which steps are to be
 printed
- E. Objective Function
 Variable coefficients must be one coefficient
 for each variable
- F. Constraints
 Constraint Constant
 Constraint Variable Coefficients
 Repeated for number of Constraints

- G. ZBAR Card
Best Known Value of ZBAR
- H. 9999 Card
If last run of series, enter 9999. If
stacked runs, enter size card.

V. References

McMillan, Claude Jr. Mathematical Programming.
New York: John Wiley & Sons, 1970.

MINT

I. General Description

MINT (Mixed Integer Programming) employs the cutting plane technique to solve integer linear programming problems. The limit of the program is 30 rows and 30 columns. The program always maximizes the objective function. To minimize, multiply all objective functions by -1. The output of the program consists of the first and last tableau of each simplex LP problem. Also included in the output is information about the cutting planes that are introduced and the constraints and variables that are eliminated.

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X,PROG=MINT
- C. //FT09F001 DD UNIT=SYSDA,SPACE=(cyl,(2,1))
- D. //SYSIN DD *
- E. Size Card
- F. Objective Function (Repeated as necessary)
- G. Constraint Cards (Repeated as necessary)
- H. Blank Card
- I. //

III. Card Preparation

- E. Size Card (Right justified)

Col 1-6	Number of Constraint Equations	(I6)
Col 7-12	Number of Columns (Including the Constraints for each Constraint)	(I6)
Col 13-18	Number of real Variables +1	(I6)
Col 19-24	Number of Artificial Variables	(I6)
- Note: Col 13-18 + Col 19-24 = Col 7-12

F. Objective Function

Col 1-6	}	Objective function variable coefficients. Additional cards may be used if necessary. (Format: 12F6.0)
Col 7-12		
.		
Col 66-72		

G. Constraint Card

Col 1-6	}	Coefficients followed by constant for the first constraint entered in successive 6-column fields, right justified, entered as integers.
Col 7-12		
.		
Col 66-72		

Note: Repeat as necessary

IV. Additional Information

All data are entered in successive 6-column fields, right justified. Decimals are permitted only in the objective function. The cutting plane technique requires that all numbers in the constraint must be integers. All real variables must be entered at the left of the tableau, followed by all slack variables, followed by all artificial variables.

V. References

Plane, Donald R., and Claude McMillan, Jr. Discrete Optimization. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1971.

SIMULATION

The simulation programs described in this chapter provide the user with methods of both discrete and continuous systems.

The most comprehensive program for discrete simulation would be the GPSS program. For those users with a problem of a continuous nature, either DYNAMO or CSMP should be used, with DYNAMO recommended for the inexperienced user. SIMSCRIPT provides an entire mathematical system that can be used for calculations and evaluations as well as simulative purposes. Q-GERT is available to those users who desire to simulate branching networks and the waiting line problems which may occur.

GPSS

I. General Description

- A. GPSS is a computer simulation program used for conducting evaluations and experiments of systems, processes, and designs. GPSS can be applied in most industrial, financial, and engineering environments to solve a variety of problem situations. GPSS is applicable to studies ranging from work teller queues to vehicular flow patterns, message switching systems, etc.
- B. The user of GPSS does not need previous computer programming experience. The GPSS program features a simple flowchart language for describing the problem or system to be simulated. When this flowchart description is transferred to punched cards and presented as input to the GPSS computer simulator program, GPSS will automatically carry out the simulation of the system and produce tabulated results.

II. Order of Cards in Input Deck

- A. //JOB CARD Class=C (Appendix A)
- B. // EXEC GPSS
- C. //SYSIN DD *
- D. GPSS **** Control *** Cards
- E. //

III. Card Preparation

See References listed below.

V. References

General Purpose Simulation System/360 Introductory User's Manual. New York: IBM Corp., 1972.

General Purpose Simulation System/360 User's Manual. New York: IBM Corp., 1972.

DYNAMO

I. General Description

DYNAMO is a computer program which compiles and executes continuous simulation models. It has been used to study business, social, economic, biological, psychological, and engineering systems. Continuous models are useful when the behavior of the system depends more on aggregate flows than upon the occurrence of discrete events. DYNAMO has been designed for the person who is problem-oriented rather than computer-oriented.

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC DYNAMO
- C. //SYSIN DD *
- D. ** DYNAMO STATEMENTS ***
- E. //DYNIN DD *
- F. //

III. Card Preparation

See References listed below.

V. References

Forrester, Jay Wright. Industrial Dynamics. Cambridge, Mass.: M.I.T. Press, 1961.

CSMP

I. General Description

- A. CSMP (Continuous System Modeling Program) is a "continuous system simulator" which combines the functional block modeling features with a powerful algebraic and logical modeling capability. The input language enables a user to prepare structure statements describing a physical system starting either from a block or a differential equation representation of the system.
- B. Output Includes
 - 1. Printing out variables
 - 2. Print-plotting of variables
 - 3. Minimum and maximum of specified variables
 - 4. Preparation of a data set for user prepared plot program

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC CSMP360
- C. //SYSIN DD *
- D. CSMP***Control***Cards
- E. ENDJOB
- F. //

III. Card Preparation

See References listed below.

V. References

System/360 Continuous System Modeling Program Application Description. New York: IBM Corp., 1971.

Systems/36 Continuous System Modeling Program User's Manual. New York: IBM Corp., 1970.

SIMSCRIPT

I. General Description

SIMSCRIPT is a versatile computer language. Problems that require numeric computation that are normally written in Fortran can be easily written using SIMSCRIPT. Subroutine linkage is fully recursive and SIMSCRIPT allows the calling of Fortran subroutines. SIMSCRIPT's real value lies in the coding of mathematical models and system simulations. SIMSCRIPT automatically provides a main timing routine to keep track of simulated time and the occurrence of events.

II. Order of Cards in Input Deck

- A. //JOB CARD
- B. // EXEC SIMCLG
- C. //SIM.SYSIN DD *
- D. ** SIMSCRIPT Statements
- E. //GO.SYSIN DD *
- F. ** Data Cards *****
- G. //

III. Card Preparation

See References listed below.

V. References

SIMSCRIPT II's User's Manual S/360-370 Version.
Release 7. Arlington, VA: Consolidated Analysis
Centers Incorporated, 1973.

Q-GERT

I. General Description

Q-GERT allows the modeling of a wide class of queueing systems in network form. A network model consists of nodes and branches. Specialized types of nodes and branches have been designed into Q-GERT in order to enhance the type of network models that can be built.

II. Order of Cards in Input Deck

- A. //JOB CARD Class=C (Appendix A)
- B. // EXEC IRF4X, PROG=QGERT
- C. //FT03F001 DD UNIT=SYSDA, SPACE=(Cyl,(2,1)),
// DCB=(RECFM=FB, LRECL=133, BLKSIZE=133)
- D. //SYSIN DD *
- E. ***QGERT Control Cards & Data***
- F. //

III. Card Preparation

See References listed below

V. References

Pritsker, A. Alan B. The Q-GERT User's Manual.
Lafayette, Ind.: Pritsker & Associates, Inc., 1974.

PLANT MANAGEMENT

A variety of programs are presented in this chapter to help the Industrial Engineers solve problems that might occur in a production environment.

CPMPERT can be used to solve scheduling and resource problems. For those with plant or room layout problems, CRAFT offers some optimal techniques. EECON is mainly concerned with the financial dealings in a production environment. To determine any waiting line problems or assembly line product flow the user would consult GERTXOR or possibly Q-GERTS from the preceding section. The last two programs, AFOPM and SMOOTH approach the problem of forecasting future demands.

CPMPERT

I. General Description

- A. CPMPERT is a program to process network scheduling problems. It provides both basic critical path scheduling (CPM) and probability analysis (PERT).
- B. Output Includes
 - 1. Listing of data, number of jobs, duration of jobs.
 - 2. Schedule of the jobs within a project, critical jobs are indicated, project cost and duration
 - 3. Simple job probabilities
 - 4. Event Probabilities
 - 5. Bar chart with float time
- C. Limitations
 - 1. Cost \leq \$999,999.99
 - 2. Maximum of 999 modes, 1400 jobs
 - 3. Nodes must be unique 3-digit integers

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X,PROG=CPMPERT
- C. //FT08F001 DD Unit=SYSDA,SPACE=(cyl,(2,1))
- D. //FT09F001 DD Unit=SYSDA,SPACE=(cyl,(2,1))
- E. //SYSIN DD *
- F. Data Header Card
- G. Data Detail Card (Repeated as needed)
- H. Blank Card
- I. //

III. Card Preparation

- F. Data Header Card
 - Col 1-80 Free Form Project Description

G. Data Detail Card

Col 1-5	3 Digit Preceding Event #	(I5)
Col 6-10	3 Digit Succeeding Event #	(I5)
Col 11-20	Optimistic time for current event	(I10)
Col 21-30	Most likely time for current event	(I10)
Col 31-40	Pessimistic time for current event	(I10)
Col 41-50	Estimated cost of current job	(I10)
Col 51-60	Scheduled completion time	(I10)
Col 61-80	Description of job	

Note: If a project completion date is to be specified, a separate card is to be used with the desired completion time in Col 51-60 and an * in Col 61. Col 62-80 can then be used for labeling program.

V. References

CPM/PERT for the IBM 1130. New York: IBM Corp., 1972.

CRAFT

I. General Description

- A. CRAFT (Computerized Relative Allocation of Facilities Technique) is a computer program which determines how a floor plan can be rearranged in order to reduce cost of activity between each pair of facilities.
- B. Output Includes
 - 1. Interdepartment product flow
 - 2. Interdepartment move cost
 - 3. Location pattern
 - 4. Total cost, cost reduction
- C. Limitations
 - Maximum of 40 departments

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X, PROG=CRAFT
- C. //SYSIN DD *
- D. Parameter Card
- E. Volume Array
- F. Unit Cost Array
- G. Initial Space Array
- H. //

III. Card Preparation

- D. Parameter Card

Col 1-2	Number of Departments	(I2)
Col 3-4	# of Rows in Spatial Nature	(I2)
Col 5-6	# of Columns in Spatial Matrix	(I2)
Col 7-8	04	
Col 9-10	I/O Control	
	00--Print First and Last	
	01--Print Each Iteration	
Col 11-12	00	
Col 13-14	# of Fixed Departments	

Col 15-16 # of First Department to be Fixed
Col 17-18 # of Next Department to be Fixed
.
.
.
Col 21-80 Same as above, 2 columns for every
additional department to be fixed in
place

V. References

Cramer, P. A., and G. C. Armour. Computerized
Relative Allocation of Facilities Technique.
New York: Share Library, 1965.

EECON

I. General Description

- A. This program computes "Equivalent Uniform Annual Cost," "Net Present Worth" and "Rate of Return Project Analysis." It is also possible to generate tables of the six basic interest factors for user-specified interest rates and time periods.
- B. Output Includes
 - 1. Interest Factor Table
 - 2. EUAC Analysis
 - 3. NPW Analysis
 - 4. Rate of Return Analysis

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X,PROG=EECON
- C. //SYSIN DD *
- D. Mode Card
- E. Title Card
- F. Data Card
- G. Stop Card
- H. //

III. Card Preparation

- D. Mode Card
 - Col 1-5 00000 Stop (Used to terminate current run)
 - 00001 Generate Interest Factor Tables
 - 00002 Perform EUAC Project Analysis
 - 00003 Perform NPW Project Analysis
 - 00004 Perform Rate-of-Return Analysis
- E. Title Card
 - Col 1-80 User supplied title up to 80 characters

F. Data Cards

If Mode=00001

Col 1-6	Interest	(F6.0)
Col 7-9	n Years	(I3)

Note: This card may be repeated. To terminate this mode of operation, punch a negative interest.

If Mode=00002

Col 1-6	Interest	(F6.0)
Col 7-9	Project Life	(I3)
Col 10-25	Initial Project Cost	(F15.0)
Col 26-40	Salvage Value	(F15.0)

Note: For the next three modes, year cards must be included. If income and expenses are constant, only 2 cards are necessary. For varying costs, enter number of cards equivalent to project life. Both methods use the following format:

Year Card 1

Col 1	0=Constant Costs	(I1)
	1=Varying Costs	(I1)

Year Card 2

Col 1-15	Income	} *	(F15.0)
Col 16-40	Expenses		(F15.0)

* May be repeated for project life

If Mode=00003

Col 1-6	Interest	(F6.0)
Col 7-9	Project Life	(I3)
Col 10-25	Initial Cost	(F15.0)
Col 26-40	Salvage Value	(F15.0)
Col 41-43	Least Common Multiple of Project Lives	(I3)

Year Card 1

Col 1	0=Constant Costs	(I3)
	1=Varying Costs	(I3)

Year Card 2

Col 1-15	Income	} *	(F15.0)
Col 16-40	Expenses		(F15.0)

* May be repeated for project life

If Mode=00004

Col 1-3	Project Life	(I3)
Col 4-18	Initial Cost	(F15.0)
Col 19-33	Salvage Value	(F15.0)

Year Card 1

Col 1	0=Constant Costs	(I3)
	1=Varying Costs	

Year Card 2

Col 1-15	Income	} *	(F15.0)
Col 16-40	Expenses		(F15.0)

* May be repeated for project life

IV. Additional Information

- A. Salvage Value may be positive, zero, or negative.
- B. Runs can be stacked together, terminating execution with stop card.

V. References

Bauer, C. S. "EECON, A Computer Program."
Orlando, FL: Florida Technological University,
1971.

GERTXOR

I. General Description

- A. GERTXOR is a digital computer program for analyzing networks that contain nodes of the exclusive -or, probabilistic type, and branching which have both a probability and a time associated with them.
- B. Output Includes
 - 1. Appropriate problem identification headings
 - 2. Paths and loop of a network
 - 3. Probability of realizing a sink node from any source node
 - 4. The mean and variance of the time to realize any sink node

II. Order of Cards in Input Deck

- A. //JOB CARD Class=A (Appendix A)
- B. // EXEC IRF4X, PROG=GERTXOR
- C. //FT05F001 DD STSOUT=A
- D. //FT08F001 DD *
- E. Constant Card
- F. Input Network Description
- G. Branch Cards (as many as needed)
- H. -13
- I. //

III. Card Preparation

- E. Constant Card
 - Col 1-9 ABDEGNOPU
- F. Input Network Description

Col 5-16	User's Name	(12A1)
Col 17-20	Problem Designation	(A3)
Col 21-22	Month	(A2)
Col 23-24	Day	(A2)
Col 25-28	Year	(A4)

Col 29-30 Loop Printout Control
 0=No print
 1=Print (I2)

Col 31-32 Path Printout Control
 0=No print
 1=Print (I2)

Col 33-42 Loop Deletion Probability
 If blank, no loops will be
 deleted. (F10.8)

Col 43-44 Branch Values
 0=Actual Printed
 1=Adjusted so the sum of node
 probabilities equal 1 (I2)

G. Branch Cards

Repeat as necessary

Col 1-4 Node beginning branch (I4)

Col 6-9 Node terminating branch (I4)

Col 11-13 Type of distribution
 (B, D, E, GA, GE, NB, NO, P, U)
 Left justified. See Section IV
 below for further details. (A3)

Col 14-20

Col 21-27

Col 28-34

Col 35-41

Col 42-48

Col 49-55

Col 56-62

Col 63-69

The definition of these fields
 depends on the type of distri-
 bution specified. See Section IV
 below.

IV. Additional Information

Mnemonic	Type Distribution	Col 14-20	Col 21-27	Col 28-34	Col 35-41
B	Binomial	Prob.	N	P	
D	Discrete	P(1)	T(1)	P(2)	T(2)
E.	Exponential	Prob.	1/A		
GA	Gamma	Prob.	1/A	1/B	
GE	Geometric	Prob.	P		
NB	Neg. Bi.	Prob.	r	p	
NO	Normal	Prob.	m	σ	
P	Poisson	Prob.	λ		
U	Uniform	Prob.	a	b	

Note: Discrete Distributions continue with P(3),
 T(3), etc. in Columns 42-69 as designated
 above.

V. References

Unknown

AFOPM

I. General Description

AFOPM is Adaptive Forecasting with Orthogonal Polynomial Models. Using Orthogonal Polynomials it is possible to perform traditional regression analysis with greater computing accuracy and reduced computing time. AFOPM is an interactive CPS program which will perform an orthogonal regression analysis allowing updating and future forecasting. AFOPM is a completely self-documenting program which can be applied up to a 10th order polynomial and up to 100 data points. AFOPM can only be run interactively.

II. Order of Cards in Input Deck

- A. LOGON (Appendix B)
- B. CPS CPSF10
- C. LOAD(AFOPM)
- D. XEQ
- E. ***afopm Control Cards & Data
- F. END
- G. LOGOFF

III. Card Preparation

Program is self-documenting. Enter Data as requested.

V. References

Unknown

SMOOTH

I. General Description

SMOOTH (Exponential Smoothing Program) performs exponential smoothing which is a technique that can be directly applied to system forecasting. The procedure does not require that back data be held. SMOOTH can be applied to zero-order through quadratic polynomials. The basis for calculating the initial conditions is a subroutine that does polynomial regression. The program automatically starts the time value (t) at t=1. The highest time value will be equal to N, the number of data points. It is at $T=N$ that the original model is formulated.

II. Order of Cards in Input Deck

BATCH

- A. //JOB CARD Class=A (Appendix A)
 - B. // EXEC IRF4X, PROG=SMOOTH
 - C. //SYSIN DD *
 - D. Size Card
 - E. Data Values
 - F. Forecast Values
 - G. Updates
 - H. //
- } May be repeated as necessary

INTERACTIVE

- A. LOGON (Appendix B)
- B. IRF4X SMOOTH
- C. *** Control Cards & Data ***
- D. LOGOFF

III. Card Preparation

BATCH

Input is freefield separated by spaces or commas

- D. Size Card
of data points ≤ 50 , degree of smoothing ≤ 3
- E. Data Values
Enter Data
- F. Forecast Values
Time value to be forecast or 0 if no forecast
- G. Update
Update to be forecast or 0 if no forecast

Note: Steps F and G may be repeated as necessary

INTERACTIVE

SMOOTH is completely self-documenting and will instruct the user as necessary.

V. References

Unknown

GENERAL AND MISCELLANEOUS

Programs treated in this chapter are more of a data analysis variety, allowing the user to take an initial look at his data to either confirm or formulate a hypothesis.

GOODFIT takes a series of data and attempts to derive its curve origin. STATV permits the user to solve state variable equations. SYMAP, PLOT, and GRAF are all programs of a plotting nature. SYMAP is extremely useful if outlines or categories are desired. PLOT can best be utilized by the user who already has an existing Fortran program and desires a plotting subroutine. GRAF is a Standalone plotter that can be utilized by anyone who has a series of points to be plotted. VREGAN is a general purpose regression program that tries to derive the relationship between a dependent and independent variable.

GOODFIT

I. General Description

- A. GOODFIT is an algorithm capable of performing generalized goodness of fit-testing on a set of n-observations. The goodness of fit tests applied are: Chi-square, Kolmogorov-Smirnov, Cramer-VonMises, and Moments. Each test can be applied to any of 10 distinct probability density functions. Only one distribution type can be tested during any one run.
- B. Output Includes
 - 1. Echo check of input data
 - 2. Statement of null and alternate hypothesis
 - 3. Statement of calculated (or theoretical) mean and variance
 - 4. Statement of the distribution parameters
 - 5. Histogram of the raw data
 - 6. Goodness of fit table containing the required calculations leading to
 - 7. Critical value and degrees of freedom for the desired test statistic

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X, PROG=GOODFIT
- C. //SYSIN DD *
- D. Size Card
- E. Format Card
- F. Means and Variances (Optional)
- G. Data
- H. Blank
- I. //

III. Card Preparation

- D. Size Card

Col 1-5	Number of data points	(I5)
---------	-----------------------	------

Col 6-10	Probability distribution desired (See Section IV Below)	(I5)
Col 11-15	1= x^2 ; 0/ x^2	(I5)
Col 16-20	1=Kolmogorov-Smirnov 0/ Kolmogorov-Smirnov	(I5)
Col 21-25	1=Cramer-VonMiseo 0/ Cramer-VonMiseo	(I5)
Col 26-30	0=Mean and Variance unknown 1=Mean and Variance known	(I5)
Col 31-35	Number of cells specified by user. If blank or 0, program assumes 10.	(I5)
Col 36-40	1=Moments test for normality 0=No	(I5)
Col 41-45	1=Biased estimation of normality 0=Unbiased estimation of normality	(I5)
Col 46-50	ID Code for Output	(A4)

E. Format Card

F-type variable format card describing input data.

F. Means and Variances

Col 1-10	Expected value of distribution	(F10.2)
Col 11-20	Variance of Distribution	(F10.2)

IV. Additional Information

For Column 10 on Size Card:

- 1=Poisson
- 2=Exponential
- 3=Normal
- 4=Gamma, Erlang-K, Chi-Square
- 5=Weibull
- 6=Lognormal
- 7=Uniform
- 8=Triangular

V. References

Phillips, Don T. "Applied Goodness of Fit Testing" (Monograph presented to The American Institute of Industrial Engineers, Inc.) 1972.

F. Parameters

Col 1-10	n ($n \leq 10$)	(I10)
Col 11-20	Δt	(F10.0)
Col 21-30	T .	(F10.0)
Col 31-40	T_f	(F10.0)

G. NLOOP

Col 1-10	Print every NLOOP stop	(I10)
----------	------------------------	-------

H. F Matrix

Col 1-10	$F(1,1)$	(F10.0)
Col 11-20	$F(1,2)$	(F10.0)
Col 21-30	$F(1,3)$	(F10.0)

·
·
·

Col 71-80	$F(1,8)$	(F10.0)
-----------	----------	---------

Note: F is entered by rows with 8F10.0 using
as many cards as needed.

V. References

Bauer, C. S. "STATV: A Computer Program."
Orlando, FL: Florida Technological University,
1971.

SYMAP

I. General Description

SYMAP is a mapping program written for the purpose of generating contour, conformline, and/or outline maps of geographic interest on the line-printer.

II. Order of Cards in Input Deck

- A. //JOB CARD Class=C (Appendix A)
- B. // EXEC SYMAP
- C. //SYSIN DD *
- D. ***SYMAP Control and Data Cards***
- E. //

III. Card Preparation

See Reference below

V. References

SYMAP Manual. Cambridge, Mass.: Harvard University Press, 1971.

PLOT

I. General Description

PLOT is a subroutine available from the Scientific Subroutine Package that allows the plotting of several cross-variables versus a bare variable.

II. Order of Cards in Input Deck

PLOT is accessible from all Fortran programs except Watfiv.

III. Card Preparation

Call PLOT (No, A, N, M, NL, NS)

No - Chart Number (3 digit maximum)

A - Matrix of data to be plotted. First column represents base variable and successive columns are the crossvariables. (Maximum is 9)

N - Number of rows in Matrix A

M - Number of columns in Matrix (equal to the total number of variables)

NL - Number of lines in the plot. If 0 is specified, 50 lines are used.

NS - Code for sorting the base data is ascending order.

0=Sorting unnecessary

1=Sorting necessary

V. References

System/360 Scientific Subroutine Package, Version III, Programmer's Manual. New York: IBM Corp., 1972.

GRAF

I. General Description

GRAF is a routine for plotting up to 10 cross variables against a base variable on a grid of 51 by 91 spaces. The data to be plotted is in the form of a vector, with the base variable being the first variable in the vector. The printout identifies the supplied variable symbols or the user has the option of specifying the maximum or minimum values of the x and y axes.

II. Order of Cards in Input Deck

- A. //JOBCARD Class=B (Appendix A)
- B. /*JOBPARM PSS=NO (Begin PSS=NO in Col 16)
- C. // EXEC IRF4X,PROG=GRAF
- D. //SYSIN DD *
- E. Size Card
- F. Fortran Format (Optional)
- G. Data
- H. Symbols and Axis Card
- I. Symbols Card (Optional)
- J. X-Axis Card (Optional)
- K. Y-Axis Card (Optional)
- L. //

III. Card Preparation

All Data is freefield and should be separated by spaces or commas.

- E. Size Card
Number of data points (rows), number of variables (columns), variable format used.
1=yes; 0=no.
- F. Fortran Format
F-Fortran Format for Data

- G. Data
Data Vector of size rows x columns. Use as many cards as needed to include all data.
- H. Symbols and Axes Card
1 if user wishes to use own symbols; 0 otherwise
1 if user wishes to supply own x-axis high and low, 0 otherwise.
1 if user wishes to supply own y-axis high and low, 0 otherwise. (e.g. 1,0,0)
- I. Symbols Card
User supplied symbols if needed must be enclosed in single quotes. (e.g. 'A', 'X', 'Y')
- J. X-Axis Card
High and low x-axis values if needed
- K. Y-Axis Card
High and low y-axis values if needed

V. References

Greenberg, Leo. Quantitative Techniques in Safety & Loss Prevention with Computer Programs. New York: P. Feldheim, 1972.

VREGAN

I. General Description

VREGAN determines the equation of a line which best fits the input data. Any of five equation families can be tested. It is possible to input up to 10 variables and let each in turn be dependent or independent. Output options are numerous including equations and regression coefficients as well as plotted residuals.

II. Order of Cards in Input Deck

- A. //JOB CARD Class=B (Appendix A)
- B. // EXEC IRF4X,PROG=VREGAN
- C. Size Cards
- D. Data Cards
- E. Variable Name Cards
- F. STOP
- G. //

III. Card Preparation

- C. Size Card

Col 1-16	Name of Problem	(4A4)
Col 17-18	Number of Variables ≤ 10	(I2)
Col 19-21	Number of Observations ≤ 100	(I5)
Col 22-23	-1=Summarized regression coefficients only 00=Equation and regression coefficients 01=00 + plot of given and calculated dependant variable	
Col 24	0=First variable input will be considered independent (x) for all combinations 1=Each input variable as independent in its turn	

Col 21 Fits data according to following options:
 (0)=Fits data to $Y = A + B * X$
 (1)=Fits data to all five families
 (2)= $Y = A * (E ** B * X)$
 (3)= $Y = A * (X ** B)$
 (4)= $Y \neq A + B/X$
 (5)= $Y = X/(A + B * X)$

D. Data Cards

All x values then all y values. Repeat as necessary. Data is entered with (7F10.6) Format.

E. Variable Name Cards

Repeat as necessary
 Col 1-12 Variable Label

IV. Additional Information

The print analysis and equation option may be left blank which sets these values to zero.

V. References

Smedley, Robert. "VREGAN, A Computer Program."
 Orlando, FL: Florida Technological University,
 1975.

APPENDIX A

Batch Utilization Language

I. General Description

Each computer program submitted to the system/360 operation system must contain some job control language statements. There are four general types of J. C. L. cards required:

1. Job Card
2. Execution Card
3. Data-definition Card
4. Delimiter Card

The above mentioned cards will be described in sufficient detail below to allow the most inexperienced user access to the computer programs described thereafter.

II. Order of Cards in Input Deck

- A. //JOB CARD
- B. // EXECUTE CARD
- C. // DATA-DEFINITION CARD
- D. *** Control Cards & Data for Programs ***
- E. // DELIMITER CARD

III. Card Preparation

A. Job Card

Col 1-2	// (All JCL cards begin with // or /* in Columns 1 & 2)
Col 3-10	Up to 8 alpha-numeric characters job name. It must begin with an alpha-character and should be descriptive to the user as to the job being run.
Col 11	Blank
Col 12-14	JOB (This is a keyword)
Col 15	Blank
Col 16	((Left Parenthesis)
Col 17-20	4 digit project number, obtained from professor or computer services.
Col 21	, (Comma)
Col 22-25	Up to 4 digit sub-project number if assigned; if not use 1
Col 26	, (Comma)
Col 27-30	4 character password obtained from professor or computer services
Col 31	, (Comma)
Col 32-34	FTU (Indicates job origin)
Col 35-36), (Right Parenthesis, Comma)
Col 37-56	Up to 20 character programmer name Enclose in single quotes if embedded blanks exist.

Col 57 , (Comma)
Col 58-63 Class= (Keyword)
Col 64 Partition size needed to run this
 job. A=60K, B=120K, C=180K,
 D=240K, E=300K,

Note: Due to variations in name and number sizes, columns may vary but commas, blanks, and parentheses must be used as indicated. This JOBCARD gives a default value of computer time. If more is needed, consult computer services.

B. Execute Card

Col 1-2 //
Col 3 Blank
Col 4-7 EXEC
Col 8 Blank
Col 9-72 Program to be executed, may be of
 the forms IRF4X, PROG=XXXX or XXXX.

C. Data-Definition Card

Col 1-2 //
Col 3-10 Alpha-numeric description, usually
 provided in program write-ups.
Col 11 Blank
Col 12-13 DD (Keyword)
Col 14 Blank

Col 15-72 Alpha-numeric description provided⁵⁰
by program write-up.

E. Delimiter Card

Col 1-2 // or /* as specified

IV. Additional Information

Example JOBCARDS

```
//GPSS JOB (1002,2,ABCD,FTU),SMITH,CLASS=B
//CSMPTRY JOB (1586,999,XYZZ,FTU),'J.J.DOE',CLASS=C
//JAN15 JOB (1096,03,ABCX,FTU),'TOM BROWN',CLASS=A
```

Example Execute Cards

```
// EXEC IRF4X,PROG=CPMPERT
// EXEC GPSS
```

Example Data Definition Cards

```
//SYSIN DD *
//FT08F001 DD UNIT=SYSDA,SPACE=(cyl,(1,1))
```


APPENDIX B

Interactive Utilization

I. General Description

When running programs interactively using the IBM 2741 terminal, it is necessary to be able to LOGON and LOGOFF the system. The system currently available is T.S.O. or time-sharing-option from IBM.

II. Order of Commands

- A. ??
- B. LOGON
- C. Password
- D. Program Call
- E. LOGOFF

III. Command Preparation

User Response

??

LOGON XXXX (See 1)

ABCD (See 2)

IRF4X,PROG=XXXX (See 3)

ATTN (See 4)

Computer Response

ENTER LOGON

ENTER PASSWORD XXXX

GOOD AFTERNOON.....

.....READY

** Execution of program
desired **

READY

LOGOFF

LOGGEDOFF

1. User ID furnished by instructor or computer services.
2. Password furnished by instructor or computer services.
3. Program desired to be executed.
4. Black button on upper right of console.

APPENDIX C

Helpful Hints

The following are some common errors that may occur even though the user believes he has followed all instructions correctly. After the error are some problem areas to check before seeking further help.

1. IHC2151 (Illegal character in data or input/output error.)
 - a. Check format card to determine if data was read incorrectly.
 - b. Check size and number of cases cards.
 - c. Check order of control cards.
2. IHC2171 (Your program was expecting to receive more data but instead read the system delimiter card.)
 - a. Check data deck for proper number of cases as specified.
 - b. Check format card to make sure it conforms to data.
 - c. Look for missing control cards.
3. OC4-OC5 (Probably exceeded program's capacity.)
 - a. Check to see what the program's limitations are.
 - b. Look over control cards to insure that all parameters are in proper columns.

4. 322 (Amount of time you allowed to run your program was exceeded or lines printed exceeded estimate given on job card.)
 - a. Change job card to allow more time or lines.
 - b. Ensure your control cards are not calling for excessive precision or vast amounts of print.
5. 804 (The program you are executing requires a larger class on job card.)
 - a. Check program write-up to ensure your job card agrees with cards as given.
 - b. Increment job class by one character.
6. 806 (The program that was requested was not found.)
 - a. Check execute card for correct spelling and format of program requested.

APPENDIX D

In order to receive updates and corrections,
please fill out the form below and mail to:

Thomas O. Peeples, I/R
Computer Services, F. T. U.
PO Box 25000
Orlando, FL 32816

Name _____

Address _____

New _____ Change of Address _____ Delete _____

Name _____

Address _____

New _____ Change of Address _____ Delete _____

Name _____

Address _____

New _____ Change of Address _____ Delete _____

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Walsh, Dorothy. A Guide for Software Documentation. New York: Advanced Computer Techniques Corporation, 1969.