Consiglio Nazionale delle Ricerche

VSAPL

Public Libraries Documentation

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CNUCE

Divisione Servizio Elaborazione Dati

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VSAPL: Public Libraries Documentation

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Contents

INTRODUCTION

This manual contains the print out of all the inplemented documentation of the APL public libraries available at CNUCE.

The authors wish to express sincere thanks to all those who have contributed to APL public libraries with their program packages which have been incorporated into the system.

The documentation in this manual have been gathered from many sources, have been tested as much as possible and found in perfect working order by the authors. However it is always possible for error to occur either in the description or in the programs in the APL public libraries. If this should happen, we would appreciate the user contacting the authors of the programs in question directly so that correction can be made.

Anyone wishing to contribute to the APL public libraries should contact the local APL coordinator at CNUCE - Pisa.

The documentation of the APL public libraries will be revised and added to continually and methodically. Users will be notified of new material by means of a message at VSAPL loading time during their terminal sessions. The updated material will be available for the user either using the on-line documentation procedure or at the CNUCE bookstore.

APL Public Libraries On-line Documentation

The documentation of the APL public libraries can be obtained by the user also at the terminal by means of the on-line procedure contained in the workspace 3 APLDOC.

Once the workspace has been loaded, the procedure starts automatically by waiting from the user one of the following possible commands:

END [APL ! CMS]
: exits from the procedure entering the environment specified by the option being APL the default value.

HELP
: prints at the terminal the sintax of all available commands.

LIB 'libnum'
: prints at the terminal the names of the workspaces contained in the library 'libnum' in the same way as the APL command ')LIB libnum'.

LIBS
: prints at the terminal the reference numbers of all the implemented public libraries with a short comment on their content as indicated in the following table.

PRINT libnum [wsname] ! ALL
: prints on the off-line printer one of the following depending on the option chosen:
  a) the documentation of the workspace 'wsname' of the library 'libnum'
  b) the documentation of all the workspaces of the library 'libnum'
  c) the documentation of all the libraries.
  Note that the off-line printer does not support the APL character set so that the documentation is printed out following the conventions established by the convertion option 19? of the auxiliary processor APL110.

TYPE libnum wsname [(ABS ! ALL]
: prints at the terminal the documentation of the workspace 'wsname' of the library 'libnum'. If the option ABS (default value) is chosen only a short abstract is printed, if the option ALL is chosen the full documentation for the specified workspace is printed.

APL PUBLIC LIBRARIES CLASSIFICATION

1 *IBM DISTRIBUTED UTILITY WORKSPACES*
2 *IBM DISTRIBUTED UTILITY WORKSPACES*
3 *GENERAL UTILITY WORKSPACES*
4 *TEXT EDITING*
5 *MISCELLANEOUS*
9 *APL TEACHING COURSE*

11 *MINIPERT (IBM PROGRAM PRODUCT)*
12 *STATPACK: A STATISTICAL PACKAGE.*
13 *STATISTICAL APPLICATIONS*
14 *TESTS FOR PARAMETRIC AND.DISTRIBUTION FREE DATA*
15 *INTERPOLATIONS*

20 *IGDS:INTERACTIVE GRAPHIC DISPLAY OF SURFACES*
21 *APL GRAPH-II (TEKTRONIX PROGRAM PRODUCT)*
22 *BASIC GRAPHIC APPLICATIONS*
23 *GRAPHIC DISPLAY OF INTERPOLATED CURVES AND SURFACES*

30 *LIMAR: MANIPULATION OF RATIONAL EXPRESSIONS*
31 *MANIPULATION OF FORMAL APL EXPRESSIONS*
32 *ARITHMETIC AND LOGICAL APPLICATIONS*
33 *FUNCTION ANALYSIS*
34 *MATRIX ALGEBRA AND EQUATIONS*

900 *ENGENEERING APPLICATIONS*
910 *CHEMISTRY AND GEOLOGY*
920 *BIOLOGICAL SCIENCES*
940 *PHARMACOLOGY*
999 *UNCATALOGUED WORKSPACES*

LIB 1 APLCOURS
IBM DISTRIBUTED

APL PRIMITIVE FUNCTIONS DRILL. MOSTLY LIMITED TO SCALAR AND VECTOR OPERATIONS WITH INTEGERS.

THE MAIN FUNCTIONS IN THIS LIBRARY WORKSPACE ARE:

TEACH
EASYDRILL

ALL OTHER FUNCTIONS ARE SUBFUNCTIONS AND ARE NOT SELF-CONTAINED.

SYNTAX	*DESCRIPTION*
TEACH	*AN EXERCISE IN APL FUNCTIONS USING SCALARS AND VECTORS. THE FUNCTION PRINTS OUT THE CHOICES AND OPTIONS AVAILABLE TO THE STUDENT. EXAMPLES ARE SELECTED AT RANDOM WITH A RANDOM STARTING POINT.*
EASYDRILL	*THIS FUNCTION IS THE SAME AS TEACH EXCEPT THE PROBLEMS SELECTED ARE GENERALLY SIMPLER IN STRUCTURE. PROBLEMS INVOLVING VECTORS OF LENGTH ZERO OR ONE ARE EXCLUDED.*

NOTE: FOR EITHER FUNCTION, A RESPONSE OF - PLEASE - WILL DISCLOSE THE PROPER ANSWER. A RESPONSE OF - STOP - WILL TERMINATE THE DRILL

LIB 1 CONVERT
IBM DISTRIBUTED

THIS WORKSPACE IS DESIGNED TO ASSIST IN THE TRANSFER OF APPLICATION WORKSPACES FROM PREVIOUS IBM APL SYSTEMS TO VS APL. IT ANALYZES THE CONTENT OF EACH UNLOCKED FUNCTION AND CONVERTS STATEMENTS WHERE POSSIBLE. IT PROVIDES A REPORT IDENTIFYING EACH STATEMENT THAT WAS CONVERTED, AND POINTS TO THOSE STATEMENTS WHICH MAY NEED MANUAL CORRECTION IN ORDER TO EXECUTE COMPATIBLY IN VS APL.
ALSO INCLUDED IS A FUNCTION TO LOCATE ALL OCCURRENCES OF ANY STATED CHARACTER STRING.

-DIFFERENCES CONSIDERED

THE FOLLOWING DIFFERENCES WHICH COULD AFFECT THE OPERATION OF USER DEFINED FUNCTIONS, ARE RECOGNIZED BY THIS CONVERT WORKSPACE.

1. THE NEW LINE (OR CARRIER RETURN) CHARACTER IS NO LONGER ALLOWED WITHIN CHARACTER CONSTANTS, AND HENCE CANNOT APPEAR IN USER DEFINED FUNCTIONS.

2. HETEROGENEOUS OUTPUT STATEMENTS, USING THE ';' AS THE SEPARATOR BETWEEN SEGMENTS, ARE NO LONGER SUPPORTED.

3. THE I-BEAM (⌶) PRIMITIVE FUNCTION IS NO LONGER SUPPORTED EITHER MONADICALLY OR DYADICALLY.

4. THE DEFINITION OF THE RESIDUE FUNCTION NOW INCLUDES NEGATIVE LEFT HAND DOMAINS. PREVIOUSLY THIS FUNCTION USED THE ABSOLUTE VALUE OF ITS LEFT HAND ARGUMENT. HENCE RESULTS WILL NOW BE DIFFERENT IN THOSE CASES WHERE THE RESIDUE FUNCTION RECEIVES NEGATIVE LEFT HAND ARGUMENTS.

5. SIMILARLY THE ENCODE FUNCTION (⊤), WHICH USES THE RESIDUE FUNCTION IMPLICITLY, NOW BEHAVES DIFFERENTLY FOR NEGATIVE LEFT HAND ARGUMENTS, AND MAY YIELD DIFFERENT RESULTS.

6. THE DEFINITION OF THE MONADIC TRANSPOSE FUNCTION (⍉) HAS BEEN CHANGED FOR THE CASE WHERE THE RIGHT HAND ARGUMENT HAS A RANK GREATER THAN TWO.

7. THE SYSTEM VARIABLES ⎕UL AND ⎕TT ARE NOT SUPPORTED BY VS APL.

8. THE LOCKED FUNCTIONS IN THE DISTRIBUTED WORKSPACE CALLED 'WSFNS', WHICH DEPEND ON THE USE OF THE DYADIC I-BEAM (⌶) FUNCTION, WILL NO LONGER BE EXECUTABLE. REVISED VERSIONS MAY HAVE TO BE COPIED FROM THE 'WSFNS' WORKSPACE DISTRIBUTED WITH VS APL, INTO APPLICATION WORKSPACES.

9. COMMENTS WITH A '⍝' TRAILING AN EXECUTABLE STATEMENT ON A LINE, ARE NOT ALLOWED IN VS APL.

-REPORT FORMATS

REPORTING IS PERFORMED ON AN EXCEPTION BASIS. LOCKED FUNCTIONS ARE SO IDENTIFIED. ALL UNLOCKED FUNCTIONS ARE PROCESSED ALPHABETICALLY, BUT ONLY THOSE REQUIRING CONVERSION, CAUTION OR WARNING MESSAGES ARE LISTED.

THERE ARE FOUR CLASSES OF ITEMS IDENTIFIED IN THE CONVERSION REPORTING. THE FIRST THREE MAY APPEAR UNDER EACH FUNCTION NAME.

1. CONVERTED. THESE ITEMS ARE CHANGED SO AS TO EXECUTE CORRECTLY IN VS APL.

2. CAUTIONS. THESE ITEMS MAY POSSIBLY CAUSE ERRORS OR INCOMPATIBILITIES, DEPENDING ON THE ACTUAL ARGUMENTS GENERATED DURING EXECUTION, OR ON A MORE DETAILED ANALYSIS OF THE CONTEXT.

3. WARNINGS. THESE ITEMS WILL CERTAINLY CAUSE ERRORS OR INCOMPATIBILITIES DURING EXECUTION, AND REQUIRE MANUAL FUNCTION EDITING.

4. WSFNS. A LIST IS GIVEN OF FUNCTION NAMES, IF ANY, THAT WERE PROBABLY COPIED AT SOME TIME FROM THE LIBRARY 1 WORKSPACE CALLED 'WSFNS'. THESE MAY NEED TO BE MANUALLY RECOPIED FROM THE LIBRARY 1 'WSFNS' WORKSPACE IN VS APL.

-ITEMS REPORTED

NOTE THAT EACH ITEM IS FOLLOWED BY A LIST OF LINE NUMBERS IN THE GIVEN FUNCTION WHERE THE ITEM WAS ENCOUNTERED.

-CONVERTED

CR - NEW LINE (OR CARRIER RETURN) CHARACTER IN A CHARACTER CONSTANT.

; - HETEROGENEOUS OUTPUT STATEMENT

⌶ - MONADIC OR INDETERMINATE USE OF THE I-BEAM PRIMITIVE FUNCTION.

-CAUTIONS

⍕ - THE ENCODE FUNCTION IF PRECEEDED BY OTHER THAN A CONSTANT.

| - DYADIC OR INDETERMINATE USE OF A '|' IF PRECEEDED BY OTHER THAN A CONSTANT. ALSO USE OF A '|' BY AN OPERATOR.

⍉ - MONADIC OR INDETERMINATE USE OF THE TRANSPOSE PRIMITIVE FUNCTION.

UL - THE SEQUENCE '⎕ UL' SUGGESTS A POSSIBLE REMNANT OF THE SYSTEM VARIABLE '⎕UL'. IF IT IS, THEN IT WILL REQUIRE MANUAL CORRECTION.

TT - THE SEQUENCE '⎕ TT' SUGGESTS A POSSIBLE REMNANT OF THE SYSTEM VARIABLE '⎕TT'. IF IT IS, THEN IT WILL REQUIRE MANUAL CORRECTION.

-WARNINGS

⌶ - DYADIC USE OF THE I-BEAM PRIMITIVE FUNCTION.

⍑ - THE ENCODE FUNCTION IF PRECEEDED BY A NEGATIVE CONSTANT.

| - THE RESIDUE FUNCTION IF PRECEEDED BY A NEGATIVE CONSTANT.

NOTE THAT WARNING MESSAGES SHOULD BE VERY RARE, SO THAT NO ATTEMPT WAS MADE TO CONVERT THESE SITUATIONS AUTOMATICALLY.

IF COMMENTS WITH A '⍝' ARE FOUND TRAILING A STATEMENT ON A LINE, THEN THEY ARE DELETED, AND THE MESSAGE 'TRAILING COMMENTS DELETED' IS PRINTED FOR THAT FUNCTION.

-RESTRICTIONS

1. THE ASSUMPTION IS MADE THAT THE APPLICATION WORKSPACE CONSISTS OF TESTED AND RUNNING PROGRAMS. THIS CONVERT WORKSPACE DOES NOT PRESUME TO MAKE A DIAGNOSTIC SYNTAX ANALYSIS, AND THE RESULTS OF THIS CONVERSION ANALYSIS WILL BE UNPREDICTABLE IF APPLIED TO ILL-FORMED APL STATEMENTS.

2. IT IS ASSUMED THAT SEGMENTS OF HETEROGENEOUS OUTPUT STATEMENTS ARE SCALARS OR VECTORS. IF HIGHER DIMENSION ARRAYS ARE PRODUCED DURING EXECUTION, THEN THE OUTPUT FORMAT MAY DIFFER FROM PREVIOUS RUNS, OR AN EXECUTION TIME ERROR MAY BE INDICATED.

3. NO CONVERSION ANALYSIS IS MADE ON LOCKED FUNCTIONS. EACH LOCKED FUNCTION IS SO INDICATED ON THE REPORT WHEN ENCOUNTERED.

4. THE CONVERTED I-BEAM FUNCTION WILL RETURN A 'NOT VALID' ERROR MESSAGE FOR ⌶23 AND ⌶28 AS THESE CASES HAVE NO CORRESPONDING FUNCTION IN VS APL. MANUAL CORRECTION WILL BE

REQUIRED. THE '⍟' IS CONVERTED TO THE '⍟⍺' FUNCTION UNLESS ITS USE IS CLEARLY DYADIC. IT MAY HAPPEN THAT THE APPARENT USE IS INDETERMINATE, BUT THAT AT EXECUTION TIME IT IS ACTUALLY DYADIC. IN THIS CASE A SYNTAX ERROR WILL BE REPORTED DURING EXECUTION, AND THE FUNCTION WILL REQUIRE MANUAL CORRECTION.

5. UNLOCKED FUNCTIONS IN THE WORKSPACE ARE ANALYZED. FUNCTIONS CAN ALSO BE CREATED DYNAMICALLY USING ⍎FX FROM VARIABLES CONTAINING CANONICAL REPRESENTATIONS OF FUNCTIONS. NO CONVERSION ANALYSIS IS MADE OF SUCH VARIABLES WHICH MUST BE UPDATED IF NECESSARY EITHER MANUALLY, OR BY PREVIOUSLY ESTABLISHING THE ASSOCIATED FUNCTIONS. SIMILARLY, A CHARACTER VECTOR WHICH MAY LATER BE EXECUTED WITH THE EXECUTE '⍎' FUNCTION, IS NOT ANALYZED OR CONVERTED. THE FUNCTION 'FINDLOC' DESCRIBED BELOW MAY BE USEFUL IN THESE SITUATIONS.

-OTHER FUNCTIONS IN THIS WORKSPACE

1. IF THERE IS A SHORTAGE OF SPACE, THEN ALL COMMENT LINES IN FUNCTIONS IN THIS (OR ANY OTHER SELECTED) WORKSPACE CAN BE DELETED WITH THE FUNCTION 'DELETECOMMENTS'. BEWARE IF USING WITH FUNCTIONS WHICH BRANCH TO ABSOLUTE LINE NUMBERS, AS LINES MAY BE RENUMBERED. A COPY OF THE WORKSPACE WITHOUT ITS FUNCTION COMMENTS CAN BE STORED SEPARATELY FOR USE.

2. THE FUNCTIONS 'OLDENCODE', 'OLDMONTRANS' AND 'OLDRESIDUE' IN THIS WORKSPACE, SIMULATE THE OPERATION OF ENCODE, MONADIC TRANSPOSE, AND RESIDUE RESPECTIVELY, AS THEY WERE IMPLEMENTED IN APL\360 (XM6). THESE FUNCTIONS CAN BE EXAMINED, OR USED IF DESIRED TO REPLACE THE CORRESPONDING FUNCTION SYMBOLS IN THE FUNCTIONS BEING CONVERTED.

3. THE MONADIC FUNCTION 'FINDLOC' TAKES ONE OR MORE CHARACTERS AS ITS ARGUMENT. THE PRINTED RESULT IDENTIFIES ALL APPEARANCES OF THE ARGUMENT IN VARIABLES OR UNLOCKED FUNCTIONS IN THE WORKSPACE. COORDINATES OF SUCH APPEARANCES ARE GIVEN IN ZERO ORIGIN. IN THE CASE OF FUNCTIONS, THE FIRST OF THE TWO COORDINATES IS THE FUNCTION LINE NUMBER. THE CONTEXT OF THE ARGUMENT IS SHOWN BY PRINTING THE ARGUMENT PLUS THE FOLLOWING CHARACTERS. THIS FUNCTION IS USEFUL IN CONVERTING WORKSPACES FROM AN APL SYSTEM WHICH ALLOWS VARIATIONS IN THE APL CHARACTER SET. IT IS ALSO AN EXTREMELY USEFUL EDITING AND DEBUGGING FACILITY.

4. THE VARIABLE 'ZTNZ' IN THIS WORKSPACE IS USEFUL IN CONVERTING CHARACTER STRINGS WRITTEN IN THE INTERNAL Z-CODES OF APL.SV INTO THE INTERNAL Z-CODES OF VS APL. 'ZTNZ' IS A 256 CHARACTER VECTOR SUCH THAT IF IT IS INDEXED WITH AN APL.SV Z-CODE, IT YIELDS A CORRESPONDING VS APL Z-CODE.

-OPERATIONS OF THIS WORKSPACE

1. LOAD THE APPLICATION WORKSPACE BEING TRANSFERED.

2. ENTER : ')PCOPY 1 CONVERT CONVERTGP'

3. IF THERE ARE ITEMS LISTED AS 'NOT COPIED', THEN THE FUNCTIONS WITH THESE NAMES IN THE APPLICATION WORKSPACE, SHOULD BE TEMPORARILY RENAMED AND STEPS 1 AND 2 REPEATED. VARIABLES WITH THESE NAMES SHOULD BE ERASED AND 'PCOPIED' BACK IN BEFORE SAVING IN STEP 6 BELOW.

4. EXECUTE THE FUNCTION 'CONVERT'. IF A 'WS FULL' ERROR MESSAGE APPEARS, THEN TEMPORARILY DIVIDE THE APPLICATION WORKSPACE IN TWO PARTS FOR CONVERSION. ALTERNATIVELY, ERASE ALL GLOBAL VARIABLES IN THE APPLICATION WORKSPACE, AND 'PCOPY' THEM BACK IN BEFORE SAVING IN STEP 6 BELOW.

5. ENTER : ')ERASE CONVERTGP'

6. RESTORE ANY TEMPORARY CHANGES MADE IN STEPS 3 AND 4 ABOVE, AND SAVE THE APPLICATION WORKSPACE BACK IN THE LIBRARY.

7. EXAMINE THE PRINTED REPORT AND MAKE ANY APPROPRIATE CHANGES.

TO USE THE FUNCTION 'FINDLOC' :

1. LOAD THE APPLICATION WORKSPACE.

2. ENTER :)PCOPY 1 CONVERT FINDLOCGP

3. ENTER : FINDLOC 'XXXX' WHERE XXXX IS A CHARACTER STRING WHICH FORMS THE SEARCH ARGUMENT.

LIB 1 EXAMPLES
IBM DISTRIBUTED

THIS WORKSPACE CONTAINS A COLLECTION OF ILLUSTRATIVE DEFINED FUNCTIONS.

THE FUNCTIONS IN THIS WORKSPACE ARE EXAMPLES OF THE POWER OF APL IN SOLVING PROBLEMS. THE FUNCTIONS ARE BRIEF, OFTEN NO MORE THAN ONE OR TWO STATEMENTS, BUT WITH POWERFUL RESULTS. THESE FUNCTIONS ARE NOT NECESSARILY THE BEST WAY, OR THE ONLY WAY, TO SOLVE THE PROBLEM. RATHER, THEY ARE ILLUSTRATIVE OF WAYS TO USE APL WHICH ARE NOT ALWAYS INTUITIVELY OBVIOUS. THEY ARE MEANT TO BE STUDIED FOR TECHNIQUES.

THE EXAMPLES FALL IN TWO CATEGORIES: SCIENTIFIC AND COMMERCIAL. THERE ARE ALSO A FEW OF INTEREST TO PROGRAMMERS SUCH AS DECIMAL-HEXADECIMAL CONVERSIONS AND HEXADECIMAL ADDITION.

SCIENTIFIC AND ENGINEERING FUNCTIONS ARE:

BIN	BINOMIAL COEFFICIENTS
COMB FC LFC	COMBINATIONS
F ZERO	ROOTS OF F
GC GCD GCV	GREATEST COMMON DIVISOR
HILB	HILBERT MATRIX
DIN DINV	MATRIX INVERSE (GAUSS-JORDAN ELIMINATION).NOTE: SUPERCEDED BY ⌹ WHICH USES HOUSEHOLDER TRANSFORMATIONS
PALL PER PERM	PERMUTATIONS
PO POL POLY POLYB	POLYNOMIALS
TRUTH	TRUTH TABLES
ASSOC	TEST ASSOCIATIVITY OF PUTATIVE ARITH. TABLES

COMMERCIAL APPLICATION FUNCTIONS ARE:

RESET ENTER LOOKUP	ENTER AND RETRIEVES ITEMS FROM ASSOCIATED STRINGS OF DATA. ONE STRING, N, IS FOR NAMES, THE OTHER, D, IS FOR CORRESPONDING DATA, SUCH AS PHONE NUMBERS.
BUILDVECTORS	CREATES A STRING OR ADDS TO A STRING ITEMS OF DATA. EACH ITEM IS MARKED WITH A SPECIAL CHARACTER.
BUILDMATRIX	REFORMATS THE STRING CREATED BY BUILDVECTORS INTO A TABLE.
FINDSTART	FINDS THE STARTING POSITION OF A 'TARGET' IN A STRING OF DATA. USEFUL FOR EDITING
REPLACE	REPLACES A 'TARGET' IN A STRING

SORTLIST	SORTS A TABLE IN ALPHABETICAL ORDER
FINDDUPS	FINDS DUPLICATED ENTRIES IN A TABLE
DELDUPS	DELETES DUPLICATED ITEMS FROM A TABLE
FINDTYPE	FINDS THE TYPE OF A VARIABLE (CHARACTER OR NUMERIC)
FINDCOORDS	FINDS THE COORDINATES OF A 'TARGET' IN A TABLE
INSERT	INSERTS A NEW ROW OF DATA INTO A TABLE
BUILDENTRIES	CREATES OR ADD TO A TABLE OF DATA

THE 'COMMERCIAL' FUNCTIONS ARE PREFACED WITH COMMENTS WHICH CALL OUT THE IMPORTANT APL PRINCIPLE USED TO ACHIEVE THE DESIRED RESULT. IT IS RECOMMENDED THAT THE NEW USER DISPLAY THE FUNCTION, READ THE COMMENTS, AND STUDY WHAT THE FUNCTION IS ACTUALLY DOING.
APL IS A VERY SUITABLE LANGUAGE FOR COMMERCIAL APPLICATIONS AS WELL AS SCIENTIFIC AND ACADEMIC. COMMERCIAL APPLICATIONS BOIL DOWN TO PROBLEMS IN MANIPULATING ARRAYS, AND APL IS AN ARRAY ORIENTED LANGUAGE WITHOUT PEER. HOWEVER, THE MANIPULATION OF ARRAYS IS USUALLY DESCRIBED IN MATHEMATICAL TERMS THAT ARE USUALLY UNFAMILIAR TO THE BUSINESS PROGRAMMER. THEREFORE, YOUR ATTENTION IS DIRECTED TO THE FOLLOWING ARRAY MANIPULATORS:

INNER PRODUCT	USED FOR TABLE LOOKUPS (∧.=)
OUTER PRODUCT	USED TO FIND SEQUENCES (∘.=)
CATENATION	USED TO ADD ROWS OR COLUMNS TO A TABLE
ROTATE	USED TO SHIFT ROWS AND COLUMNS
TRANSPOSE	USED TO REORIENT A TABLE
COMPRSSION	USED TO ELIMINATE ROWS OR COLUMNS FROM A TABLE
EXPANSION	USED TO INSERT ROWS OR COLUMNS IN A TABLE
DECODE	USED TO CODIFY SHORT CHARACTER STRINGS AS NUMBERS WHICH CAN BE SORTED
GRADE	USED TO SORT NUMBERS IN ASCENDING OR DESCENDING SEQUENCE

INSTRUCTIONS FOR USE OF EACH FUNCTION IS CONTAINED IN THE VARIABLE OF THE SAME NAME AS THE FUNCTION BUT PREFIXED WITH THE LETTER 'D'. FOR EXAMPLE, SORTLIST IS DESCRIBED BY DSORTLIST.

```
      DSORTLIST

SYNTAX                SORTLIST NAMES
```

THIS FUNCTION SORTS A LIST OF NAMES (ROWS OF MATRIX OR TABLE) IN ASCENDING ORDER BASED ON THE SORTING SEQUENCE DEFINED IN 'SORTSEQ'.

LIB 1 FORMAT
IBM DISTRIBUTED

THE FUNCTION FMT IN THIS WORKSPACE HELPS FORMAT NUMERIC DATA FOR REPORTS

THE FUNCTION FMT IN THIS WORKSPACE IS INTENDED TO ILLUSTRATE THE USE OF TWO NEW PRIMITIVE FACILITIES, THE DYADIC FORMAT FUNCTION AND THE SCAN OPERATOR, AS WELL AS THE USE OF ARRAY OPERATIONS, INSTEAD OF EXPLICIT ITERATION, WHERE SUCH USE IS NOT COMPLETELY OBVIOUS. AT THE SAME TIME, THE FUNCTION SHOULD PROVE USEFUL IN GENERATING MANY VARIATIONS IN THE COMPOSITION OF NUMERIC OUTPUT: IT ALLOWS THE INCLUSION OF COMMAS AS SEPARATORS ACCORDING TO NORMAL CONVENTIONS, PROVIDES FOR EXTENSION BY LEADING OR TRAILING ZEROS, PERMITS ARBITRARY SYMBOLS TO BE USED AS INDICATORS OF NEGATIVE NUMBERS, AND ALLOWS ARBITRARY TEXT (WITHIN SOME LIMITS) TO BE USED IN ASSOCIATION WITH EACH ROW OF NUMERICAL OUTPUT.

THE SYNTAX OF THE FUNCTION IS: Z←P FMT A

THE SHAPE OF THE RESULT IS: ⍴Z←→(¯1↓⍴A),⍴,P

THE LEFT ARGUMENT IS A LITERAL REPRESENTATION, OR PICTURE, OF THE FORM DESIRED FOR THE RESULT. IN GENERAL TERMS, DIGITS IN THE PICTURE GIVE THE POSITIONS IN WHICH DIGITS ARE TO APPEAR IN THE RESULT, AND OTHER CHARACTERS IN THE PICTURE ARE EITHER DECORATIONS OR HAVE SOME SPECIAL SIGNIFICANCE. THE RIGHT ARGUMENT MAY BE ANY ARRAY OF NUMBERS, AND THE LEFT ARGUMENT MUST HAVE AS MANY FIELDS AS THE NUMBER OF COLUMNS (LAST DIMENSION) OF THE RIGHT ARGUMENT. FIELDS ARE DETERMINED BY SPACES AND DIGITS IN SUCH A WAY THAT EXTRANEOUS FIELD MARKERS ARE NOT REQUIRED.

FURTHER INFORMATION ON THE USE OF FMT IS AVAILABLE IN THIS WORKSPACE IN TWO FORMS:

1. THERE ARE A NUMBER OF PREPARED EXAMPLES IN THE FORM OF CHARACTER VECTORS E1 THROUGH E4, WHICH CAN BE EXECUTED BY ⍎E1, ETC., AND SEVERAL PATTERNS, P1 THROUGH P6, THAT SHOW VARIATIONS IN THE LEFT ARGUMENT FOR FMT.

2. THERE IS ALSO A DESCRIPTIVE TEXT, IN THE FORM OF A RIGOROUS DEFINITION OF THE LEFT ARGUMENT FOR FMT. THIS TEXT IS CALLED PATTERNDEF, IS ABOUT TWO PAGES LONG, AND USES P1 THROUGH P6 TO ILLUSTRATE THE RULES.

LIB 1 MEDIT AND LIB 1 SEDIT
IBM DISTRIBUTED

THE WORKSPACES MEDIT AND SEDIT ARE USEFUL FOR EDITING LINE TYPE DATA. THEY ARE FUNCTIONALLY EQUIVALENT BUT SEDIT STORES TEXT IN A STRING WITH ALL OF THE BLANKS REMOVED WHILE MEDIT STORES ITS TEXT IN A MATRIX. MEDIT IS FASTER THAN SEDIT BUT TAKES MORE SPACE.

THE FUNCTIONS IN THESE WORK SPACES ARE INTENDED TO ASSIST IN CARD ENTRY AND PROGRAM EDITING OPERATIONS. THE FUNCTIONS WORK IN EITHER ORIGIN BUT ALWAYS ASSUME COUNTING FROM ZERO.

THE VARIABLE OR FUNCTION TO BE EDITED MAY BE COPIED INTO THIS WS, OR THE OBJECTS IN THIS WORKSPACE MAY BE COPIED (USING THE "PCOPY" COMMAND AND REFERENCING THEM BY THE GROUP NAME "EDITGP") INTO THE USER'S WS.

THE CONCEPT OF A "CURRENT LINE" IS EMPLOYED. THE VARIABLE "LN" CAN ALWAYS BE REFERENCED TO DETERMINE THE CURRENT LINE. MOST FUNCTIONS USE THE CURRENT LINE VALUE AND RESET IT TO A NEW VALUE AFTER THE OPERATION. LINE NUMBERING IS IN ZERO ORIGIN WITH THE TOP LINE ALWAYS BEING NUMBER 0.

THE AVAILABLE FUNCTIONS ARE DESCRIBED IN ALPHABETICAL ORDER. THOSE PRECEEDED BY "R←" INDICATE FUNCTIONS WHICH RETURN AN EXPLICIT RESULT.

AFTER — TAKES LINE INPUT FROM THE KEYBOARD AND INSERTS IT INTO THE STORED TEXT AFTER THE CURRENT LINE. EVALUATED INPUT MAY BE REQUESTED BY ENTERING □: ALONE ON AN INPUT LINE. AN EMPTY INPUT LINE INDICATES END OF INSERTION. THE NEW CURRENT LINE IS THE LAST LINE INSERTED.

ADD — CAUSES NEW TEXT TO BE ADDED AT THE END OF THE TEXT. THE NEW CURRENT LINE IS THE NEW BOTTOM LINE.

APLFIN N — TAKES THE APL FUNCTION WHOSE NAME IS IN N, AND FORMATS IT FOR THIS TEXT PROCESSOR. AN EXAMPLE IS :

```
APLFIN 'FNNAME'
```

THE CURRENT LINE IS SET TO ZERO. AFTER EDITING, THE APL FUNCTION MAY BE REDEFINED BY THE STATEMENT :

```
□FX LIST ALL
```

APLVIN N — TAKES THE CHARACTER MATRIX CONTAINED IN N AND FORMATS IT FOR THIS TEXT PROCESSOR. AN EXAMPLE IS :

```
APLVIN VARNAME
```

THE CURRENT LINE IS SET TO ZERO. AFTER EDITING, THE VARIABLE MAY BE REDEFINED BY THE STATEMENT :

```
VARNAME←LIST ALL
```

R←AT L — CHANGES THE LINE NUMBER "LN" TO L AND RETURNS 1 AS A RESULT MAY BE USED AS IN REPLACE AT 32 .

R←ALL — MOVES THE LINE NUMBER "LN" TO THE TOP OF THE TEXT AND RETURNS THE NUMBER OF LINES IN THE TEXT. TO BE USED AS IN LIST ALL .

BEFORE — SAME AS AFTER, BUT THE INPUT TEXT IS INSERTED BEFORE THE CURRENT LINE.

R←BOT — MOVES THE LINE NUMBER "LN" TO THE BOTTOM OF THE TEXT AND RETURNS THE LINE NUMBER OF THE LAST LINE (COUNTING FROM 0).

R←C — CONTEXT LOOK-UP EDITING FUNCTION WHICH APPLIES TO THE CURRENT LINE. THE USER IS PROMPTED FOR OLD TEXT AND FOR THE NEW REPLACEMENT TEXT. THE IMAGE OF THE REPLACED LINE IS RETURNED AS THE EXPLICIT RESULT.
THE VARIABLE CCOL (USUALLY SET AT 71) IS USED BY C AND CHANGE TO AVOID REPLACING A SEQUENCE NUMBER BY A DIFFERENT LENGTH FIELD OR A COMMENT THAT HAS BEEN DISPLACED INTO THE SEQUENCE NUMBER FIELD. COMMENTS EXCEEDING THE CRITICAL COLUMN ARE TRUNCATED. "LN" IS UNCHANGED.

CHANGE N — CONTEXT EDITING FUNCTION WHICH PROMPTS THE USER FOR OLD TEXT AND FOR REPLACEMENT TEXT. THE NEW TEXT WILL REPLACE EACH OCCURENCE OF THE OLD TEXT WITHIN THE N LINES STARTING WITH THE CURRENT LINE.
AN EXAMPLE OF USE IS :

```
CHANGE 3 FROM 37
```

THE NEW CURRENT LINE IS THE LAST LINE BEING CHANGED.

CLEAR — RESETS THE VARIABLES IN WHICH TEXT IS STORED. SETS "CCOL" TO 71, AND "LREC" TO 80.
THE CURRENT LINE IS SET TO 1.

DELETE N — DELETES N LINES STARTING WITH THE CURRENT ONE.
"LN" IS UNCHANGED.

R←D N — MOVES THE LINE NUMBER "LN" DOWN N LINES AND RETURNS THAT LINE AS A RESULT.

R←FIND N — PROMPTS THE USER FOR TEXT, AND THEN SEARCHES THROUGH THE N LINES STARTING WITH THE CURRENT LINE FOR THE TEXT. THE FIRST LINE (IF ANY) IN WHICH THE TEXT ISE FOUND IS RETURNED AS THE EXPLICIT RESULT. THE NEW CURRENT LINE IS EITHER THAT LINE ON WHICH THE TEXT IS FIRST FOUND, OR IF NOT FOUND, IT IS ONE PLUS THE LAST LINE SEARCHED.
AN EXAMPLE OF USE IS :

```
FIND ALL
```

R←A FROM B SETS THE LINE NUMBER TO B AND RETURNS A AS A RESULT. AN EXAMPLE OF USE IS :

```
      LIST 5 FROM 14
```

R←LIST N RETURNS N LINES STARTING WITH THE CURRENT ONE. THE NEW CURRENT LINE IS ONE PLUS THE LAST LINE LISTED.

R←NUMBER A TAKES THE CHARACTER MATRIX IN "A" AND RETURNS A RESULT WHICH IS "A" WITH LINE NUMBERS ATTACHED ON THE LEFT. AN EXAMPLE OF USE IS :

```
      NUMBER LIST 7 FROM 13
```

THE ORIGIN FOR NUMBERING IS COMPUTED AS "LN" LESS THE NUMBER OF ROWS IN "A".

REPLACE N ACCEPTS KEYBOARD INPUT WITH SAME RULES AS AFTER, AND REPLACES N LINES STARTING WITH THE CURRENT ONE. THE NEW CURRENT LINE IS THE LAST LINE INSERTED.

START CLEARS THE STORED TEXT AND CALLS "AFTER" FOR INPUT OF NEW TEXT. THE RESULTING CURPENT LINE IS THE LAST LINE ENTERED.

R←A THRU B SETS THE CURRENT LINE NUMBER TO A AND RETURNS (1+B-A). AN EXAMPLE IS :

```
      LIST 10 THRU 18
```

R←TOP MOVES THE LINE NUMBER TO THE TOP OF THE TEXT AND ALWAYS RETURNS A RESULT OF 0.

R←U N MOVES THE LINE NUMBER UP N LINES AND RETURNS THAT LINE.

TABS N ASSISTS IN SETTING TAB STOPS ON 2741 LIKE TERMINALS BY SPACING AND PAUSING AT THE POSITIONS INDICATED BY THE VECTOR OF INTEGERS IN N.

LIB 1 SBIC
IBM DISTRIBUTED

THIS WORKSPACE CONTAINS THE APPLICATION ILLUSTRATED IN THE INTRODUCTION TO THE APL LANGUAGE MANUAL (GC26-3847). IT IS A SKELETAL SYSTEM FOR SALES, BILLING, AND INVENTORY CONTROL.

THIS WORKSPACE CONTAINS FUNCTIONS FOR RECORDING ORDERS, MAINTAINING AN INVENTORY, AND PREPARING INVOICES. IT IS A SKELETAL SYSTEM DESIGNED TO ILLUSTRATE THE USE OF APL IN COMMERCIAL DATA PROCESSING.

THE VARIABLES CUSTLIST, ORDLIST, AND STOCKLIST CARRY, RESPECTIVELY, CUSTOMER NAMES AND ADDRESSES KEYED TO A CUSTOMER NUMBER, ORDERS BY STOCK NUMBER AND CUSTOMER NUMBER, AND THE INVENTORY LIST OF STOCK ITEMS. INVNO IS A COUNTER FOR SUCCESSIVE INVOICE NUMBERS, LOW INDICATES ITEMS TO BE REORDERED, AND MTH HOLDS NAMES FOR MONTHS OF THE YEAR.

WHEN DISPLAYING THE STOCK LIST OR CUSTOMER LIST ON A TYPEWRITER TERMINAL IT WILL BE DESIRABLE TO CHANGE TO A TYPE-ELEMENT HAVING BOTH UPPER AND LOWER CASE ALPHABETS.

MEANINGFUL STATEMENTS IN THIS WORKSPACE ARE:

```
NEWSTOCK
ORDERENTRY
PRINT INVOICE ORDER N
RESTOCK
```

WHERE N IS A CUSTOMER NUMBER. FOR CONSISTENCY WITH THE DATA ALREADY ENTERED, NEWSTOCK AND PRINT SHOULD ALSO BE USED WITH A TYPE-ELEMENT THAT HAS BOTH ALPHABETS.

THE FUNCTIONS ADDRESS, DATE, GET, AND PUT ARE NOT NORMALLY INVOKED BY A DIRECT KEYBOARD ENTRY, BUT ARE USED BY THE VARIOUS FUNCTIONS NOTED ABOVE.

LIB 1 TYPEDRIL
IBM DISTRIBUTED

A TIMED TYPING EXERCISE

THE MAIN FUNCTION IN THIS WORKSPACE IS: TYPEDRILL. ALL OTHER FUNCTIONS IN THIS WORKSPACE ARE USED AS SUBFUNCTIONS.

SYNTAX	DESCRIPTION
TYPEDRILL	A TIMED TYPING EXERCISE. WHEN EXECUTING TYPEDRILL THE SYSTEM RESPONDS WITH A STATEMENT - YOU ARE IN THE CONTROL STATE. FOUR COMMANDS ARE AT YOUR DISPOSAL: ENTER, DRILL, STAT OR STOP. THE COMMAND ENTER WILL BRING YOU INTO THE ENTRY STATE. IN THIS STATE YOU TYPE ONE-LINE SENTENCES, CHARACTERS OR APL EXPRESSIONS YOU WISH TO BE DRILLED ON. TYPING ONLY A CARRIAGE RETURN CAUSES A RETURN TO THE CONTROL STATE. THE COMMAND DRILL PRODUCES RANDOMLY THE LINES ENTERED VIA THE ENTER STATE. THE LINES ARE PRODUCED ONE LINE AT A TIME AND YOU ARE EXPECTED TO RETYPE THE LINE. IF IT IS ERROR-FREE, THE TIME REQUIRED TO TYPE THE LINE IS SHOWN. IF NOT, YOU ARE ASKED TO RETYPE IT. AGAIN, TYPING ONLY A CARRIAGE RETURN CAUSES A RETURN TO THE CONTROL STATE. THE COMMAND STAT DISPLAYS ACCUMULATED STATISTICS. THE VERTICAL AXIS IS THE TIME/SEC(*) AND THE HORIZONTAL AXIS SHOWS THE TRIAL NUMBERS(o). A VERTICAL ARROW(↑) INDICATES THAT THE TIME EXCEEDS THE LIMIT OF THE GRAPH. YOU ARE AUTOMATICALLY RETURNED TO THE CONTROL STATE. THE COMMAND STOP DISPLAYS THE ACCUMULATED STATISTICS AND TERMINATES THE DRILL.

LIB 1 WSFNS
IBM DISTRIBUTED

THE FUNCTIONS IN THIS WORKSPACE PROVIDE A COMPATIBLE MIGRATION PATH TO VS APL SYSTEM VARIABLES AND FUNCTIONS FOR ORIGIN, DIGITS, WIDTH, FUZZ, DELAY, AND RANDOM LINK. THE USER IS URGED TO USE THE VS APL SYSTEM FUNCTIONS AND VARIABLES DIRECTLY.

SYNTAX	PREFERABLE TO USE	ARGUMENT OF WSFNS FUNCTION	DESCRIPTION
A←SETLINK B	⎕RL←B	A NUMERIC SCALAR OR ONE ELEMENT VECTOR; AN INTEGER BETWEEN 1 AND ¯1+2*31 INCLUSIVE. IN A CLEAR WS, THE LINK VALUE IS 7*5.	SETS THE LINK VALUE IN THE CHAIN OF NUMBERS FOR THE ROLL AND DEAL FUNCTIONS.
DELAY B	A←⎕DL B	A SCALAR OR VECTOR WITH A SINGLE NUMERICAL VALUE.	DELAYS EXECUTION FOR B SECONDS.
A←DIGITS B	⎕PP←B	A NUMERIC SCALAR OR ONE ELEMENT VECTOR BETWEEN 1 AND 16 INCLUSIVE. IN A CLEAR WS, THE DIGITS VALUE IS 10.	SETS DIGITS VALUE TO B AND RETURNS OLD VALUE.
A←ORIGIN B	⎕IO←B	A NUMERIC SCALAR OR ONE ELEMENT VECTOR OF EITHER ZERO OR ONE. IN A CLEAR WS, THE ORIGIN VALUE IS 1.	SETS ORIGIN VALUE TO B AND RETURNS OLD VALUE.
A←SETFUZZ B	⎕CT←EPS	AN INTEGER SCALAR BETWEEN ZERO AND 31, INCLUSIVE. (SEE APL LANGUAGE MANUAL FOR USE OF ⎕CT.)	CAUSES THE ∈⍳⌊⌈<≤=≥>≠ FUNCTIONS TO IGNORE B LOW ORDER BITS. THE PREVIOUS VALUE OF FUZZ IS RETURNED.
A←WIDTH B	⎕PW←B	A NUMERIC SCALAR OR ONE ELEMENT VECTOR; USE AN INTEGER BETWEEN 30 AND 255 INCLUSIVE. IN A CLEAR WS, THE WIDTH VALUE IS 120.	SETS WIDTH VALUE TO B AND RETURNS OLD VALUE.

CPCMSFNS	2.1
DATACON	2.5
PRINT	2'.8
VSAMFNS	2.13

LIB 2 CPCMSFNS
IBM DISTRIBUTED

THIS WORKSPACE CONTAINS FUNCTIONS THAT ALLOW A USER TO ENTER CP OR CMS COMMANDS AND USE THE AVAILABLE SERVICES WITHOUT SIGNING OFF FROM APL.

THE FUNCTIONS ARE DESIGNED TO MEET THE MOST COMMON NEEDS AND THUS MAY NOT SERVE A PARTICULAR USERS REQUIREMENT. FOR THIS REASON NO FUNCTION IS LOCKED AND, IF NECESSARY, A USER MAY MODIFY A FUNCTION TO BETTER SUIT HIS PROBLEM.

ALTHOUGH THEY WILL SERVE MOST NEEDS WITHOUT ALTERATION, THESE FUNCTIONS SHOULD PROPERLY BE THOUGHT OF AS MODELS TO BE USED AS ONE SEES FIT. FOR EXAMPLE, THEY MAY NOT INSPECT ARGUMENTS FOR SHAPE, TYPE, ETC. IF THE USER WISHES SUCH DIAGNOSTICS HE MAY ADD THEM HIMSELF.

-USING INFORMATION

CMS∆ TYPING CMS∆ WILL TRANSFER ONE FROM THE APL ENVIRONMENT TO THE CMS SUBSET ENVIRONMENT. IN THIS STATE THE USER IS COMMUNICATING DIRECTLY WITH CMS AND HE MAY ISSUE A SERIES OF CMS COMMANDS SUCH AS PRINT, PUNCH, ETC. ANY CMS COMMAND MAY BE TYPED, BUT ONLY THOSE WHICH WILL NOT AFFECT THE TEMPORARILY SUSPENDED APL ENVIRONMENT WILL BE EXECUTED; OTHER COMMANDS, SUCH AS EDIT, WILL RESULT IN AN INVALID SUBSET COMMAND MESSAGE. TYPING RETURN WILL CAUSE THE USER TO RETURN TO THE APL ENVIRONMENT.
CAUTION SHOULD BE TAKEN WHEN EXECUTING EXECS OR COMMANDS THAT CHANGE TERMINAL OUTPUT OPTIONS SUCH AS THE SPOOL CONS COMMAND OR THE TERM COMMAND. IT IS ALSO IMPORTANT TO AVOID CHANGING OTHER OPTIONS SPECIFIED IN THE APL EXEC USED TO START APL.

CP∆ TYPING CP∆ WILL TRANSFER ONE FROM THE APL ENVIRONMENT TO THE CP ENVIRONMENT. IN THIS STATE THE USER IS COMMUNICATING DIRECTLY WITH CP AND HE MAY ISSUE A SERIES OF CP COMMANDS SUCH AS SPOOL, QUERY, DETACH, ETC. TYPING B WILL CAUSE THE USER TO RETURN TO THE APL ENVIRONMENT.
WARNING: SOME COMMANDS MAY CAUSE ABRUPT FAILURE OF APL AND LOSS OF THE ACTIVE WORKSPACE. FOR EXAMPLE, DEFINE STORAGE AND IPL CMS ARE DISASTROUS UNDER ANY CIRCUMSTANCES.

DISC∆ IF A FUNCTION EXECUTES 1 DISC∆ 1 THEN THE PHONE LINE WILL BE DISCONNECTED AND THE FUNCTION WILL CONTINUE EXECUTING UNTIL IT IS DONE (OR UNTIL IT TRIES TO UNLOCK THE KEYBOARD LOOKING FOR INPUT). WHEN EXECUTION IS COMPLETED, THEN THE USER WILL BE LOGGED-OFF.

1 DISC∆ 0 WILL BEHAVE AS ABOVE EXCEPT THAT A)CONTINUE COMMAND WILL BE PUT ON THE END OF THE CMS STACK SO THAT AFTER EXECUTION IS DONE, THE SYSTEM WILL SAVE THE WORKSPACE IN CONTINUE BEFORE THE LOG-OFF OCCURS. IF THIS OPTION IS SELECTED THEN THE USERS FUNCTION SHOULD NOT SUBSEQUENTLY PUT SOMETHING ON THE CMS STACK.

IF THE USER WISHES TO DISCONNECT A JOB WHICH WILL ASK FOR KEYBOARD INPUT THEN HE MAY MAKE USE OF APL101 TO STACK THE INPUT JUST AS 1 DISC 0 STACKS THE APL CONTINUE COMMAND.

THE ABOVE USAGE WILL CAUSE THE USER TO LOSE ANY OUTPUT TYPED BY HIS JOB. HE CAN, INSTEAD OF THE ABOVE, USE 0 DISC∆ α WHERE α IS EITHER 0 OR 1 AS IN THE ABOVE CASES. THIS WILL CAUSE THE CONSOLE OUTPUT TO BE SPOOLED TO HIS VIRTUAL READER. WHEN HE LOGS-ON AGAIN TO APL HE MAY EXECUTE PRT∆CON (ALSO IN THIS WORKSPACE) TO HAVE THE CONSOLE FILE PRINTED AT HIS TERMINAL. WARNING: LONG CONSOLE OUTPUT LINES (> 132 CHARS INCLUDING IDLES AND OTHER TERMINAL CONTROL CHARACTERS) WILL NOT BE SPOOLED TO THE CONSOLE. SHORTER LINES MAY ALSO BE LOST IF WRITTEN TO THE CONSOLE AS ONE RECORD (I.E. BLOCKED) AND GREATER THAN 132 CHARACTERS. IN ADDITION, ERROR MSGS ISSUED DURING FUNCTION EXECUTION MAY BE WRITTEN TO THE CONSOLE ONLY PARTIALLY CORRECT. IN ANY CASE, PRT∆CONS PRINTS EXACTLY WHAT APPEARS IN THE CONSOLE FILE.

IF A USER DIALS BACK INTO THE SYSTEM BEFORE HIS JOB IS COMPLETED HE WILL RECEIVE A RECONNECT MESSAGE. IF THIS HAPPENS THEN HE MUST TYPE ...

```
TERM APL ON ATTN OFF LINESIZE 255
CP SET TIMER REAL
CP SET EMSG OFF
CP SET IMSG OFF
SP CON STOP CLOSE
BEGIN
```

F∆O THIS FUNCTION IS PROVIDED TO FACILITATE THE USE OF AUXILIARY PROCESSOR 111, THE FILEDEF I/O PROCESSOR. IT WILL ISSUE APPROPRIATE CMS FILEDEF COMMANDS, GIVE VARIABLES A CORRECT INITIAL VALUE, AND OFFER THEM TO THE PROCESSOR. IT IS USED IN THE FORM ...

```
α F∆O ω
```

α IS A NAME TO BE USED FOR THE RECORD VARIABLE. αC

WILL ALSO BE ESTABLISHED AS A CONTROL VARIABLE FOR THE DATA SET AND α WILL BE THE FILEDEF DD-NAME.

ω MAY BE ANY OF THE FOLLOWING: PRINTER, PUNCH, READER, TERMINAL, OR DUMMY (IT MAY ALSO REFER TO DISK FILES AS WILL BE DISCUSSED LATER). THUS ...

```
CARD FΔO READER
```

WILL ESTABLISH CARD AS A SHARED VARIABLE WHICH WILL GET RECORDS FROM THE VIRTUAL CARD READER AND CARDC AS A SHARED VARIABLE WHICH WILL TRANSMIT CONTROL INFORMATION, SUCH AS AN EOF CONDITION. ω MAY SPECIFY A CONVERSION OPTION BY APPENDING THE AP111 OPTION. THE DEFAULT CONVERSIONS ARE ...

```
PRINTER (370
PUNCH (370
READER (370
TERMINAL (APL
DUMMY (VAR
```

CMS DISK FILES MAY BE ACCESSED BY USING AN ω HAVING THE FORM ...

```
DISK NAM (CVT FMT MOD
```

DISK IS ACTUALLY THE LETTERS DISK; THE OTHER WORDS REPRESENT ARGUMENTS. THE NAM (CVT ARGUMENT IS EXACTLY THE SAME AS IN THE INITIAL VALUES OF VARIABLES OFFERED TO AP110, THE CMS DISK I/O PROCESSOR. FMT SPECIFIES THE FORMAT AS Fρ OR Vρ WHERE ρ REPRESENTS THE LENGTH OF THE DATA (FΔO WILL AUTOMATICALLY ADD THE FOUR BYTE OVERHEAD FOR VARIABLE FORMAT RECORDS). FMT DOES NOT NEED TO BE GIVEN; THE DEFAULT IS V796 AND IN ANY CASE, IF THE FILE ALREADY EXISTS, THE TRUE CHARACTERISTICS WILL BE USED. MOD SPECIFIES THAT A FILE IS TO BE MODIFIED AND THUS THE RECORD POINTER SHOULD BE SET AT THE END OF THE FILE; THE LETTERS MOD MUST BE USED FOR THIS OPTION. THE OPTIONS FOLLOWING THE (MAY OCCUR IN ANY ORDER.

NOTES:

1. *THE FIRST WORD OF ω IS DECODED BY LOOKING AT ONLY THE MINIMAL AMOUNT. THUS THE USER MAY USE R (OR EVEN REALLY?) TO INDICATE THE READER. SIMILARLY PRINTER MAY BE SHORTENED TO PR.*

2. THE NAME α MUST BE DIFFERENT FROM NAMES USED BY THE FΔO FUNCTION. THIS FUNCTION USES VARIABLE NAMES CONSISTING OF A SINGLE UNDERLINED LETTER. ITS LABELS ARE ALL THREE UNDERLINED LETTERS AND THE ONLY FUNCTION IT REFERENCES IS PARSEΔ.

3. IF THE DISK OPTION IS USED THEN THE PARSEΔ FUNCTION WILL BE REQUIRED.

4. IF THE DISK OPTION IS USED THEN THE CMS DISK FILE CMS EXEC WILL BE CREATED AND DESTROYED.

5. NO CORRESPONDING CLOSE THE FILE FUNCTION IS PROVIDED SINCE THIS IS MERELY A MATTER OF RETRACTING THE SHARES.

PARSEΔ THIS FUNCTION IS PROVIDED PRIMARILY FOR USE BY THE FΔO FUNCTION, BUT IT MAY BE USED BY OTHERS. IT ACCEPTS A CHARACTER STRING RIGHT ARGUMENT AND PRODUCES A CHARACTER ARRAY. THE ARRAY CONSISTS OF TOKENS FROM THE STRING, ONE PER ROW. THE BREAK CHARACTERS ARE BLANK AND (. THE (IS CONSIDERED A TOKEN.

QTΔ THIS FUNCTION CAUSES TIME INFORMATION TO BE TYPED ON THE TERMINAL. THE INFORMATION INCLUDES: THE TIME OF DAY, THE DATE, THE LENGTH OF TIME THE USER HAS BEEN USING THE SYSTEM, THE AMOUNT OF VIRTUAL CPU TIME USED AND THE TOTAL CPU TIME USED. THE CP QUERY TIME COMMAND IS USED IN THIS FUNCTION.

SLΔ THIS FUNCTION CAUSES THE KEYBOARD TO LOCKUP AND THE USER'S TERMINAL ENTERS A DORMANT STATE DURING WHICH HE WILL ACCUMULATE NO CPU TIME. SINCE THE KEYBOARD IS LOCKED ANY INCOMING MESSAGES WILL BE TYPED, AS LONG AS MSG OFF IS NOT IN EFFECT. SINCE THIS FUNCTION USES THE CP SLEEP COMMAND, THE USER CAN RETURN TO THE APL ENVIRONMENT BY SIGNALLING ATTENTION.

LIB 2 DATACON
IBM DISTRIBUTED

THE FUNCTIONS ON THIS WORKSPACE ASSIST A USER IN CONVERTING SYSTEM/370 INTERNAL DATA FORMATS TO AND FROM APL CHARACTERS AND NUMBERS.
THESE ARE SPECIALLY USEFUL FOR MANIPULATING FIELDS WITHIN RECORDS WHICH ARE TRANSFERRED AS ROW BYTES TO AND FROM ACTIVE APL WORKSPACES. THIS HAPPENS WITH VSAM FILES, OR WITH CMS FILES USING BYTE CON.VERSION

IF THE FOLLOWING FUNCTIONS ENCOUNTER AN INVALID ARGUMENT, THEY PRINT A MESSAGE CONSISTING OF THE FUNCTION NAME FOLLOWED BY THE WORDS 'DOMAIN ERROR'. THEY THEN EXIT WITHOUT ASSIGNING A RESULT. HENCE THE APPLICATION FUNCTION WILL HALT WITH A 'VALUE ERROR' POINTING TO THE DATA CONVERSION FUNCTION WHICH WAS EXPECTED TO PROVIDE A VALUE. THE ARGUMENT CAN THEN BE CHECKED BY THE FOLLOWING DEFINITIONS FOR EACH FUNCTION.

A←ECI C (EBCDIC CHARACTERS IN)

'C' IS A CHARACTER ARRAY.
RESULT : A CHARACTER ARRAY OF THE SAME SIZE AND SHAPE AS 'C'. IT CONTAINS THE APL CHARACTERS WHICH ARE EQUIVALENT TO THE EBCDIC CHARACTERS REPRESENTED IN 'C'. TRANSLATION IS PERFORMED USING THE GLOBAL VARIABLE 'ZC'. ('ZC' IS A 256 CHARACTER VECTOR WHICH IF INDEXED WITH AN EBCDIC CODE VALUE GIVES A UNIQUE APL CHARACTER CODE.)

C←ECO A (EBCDIC CHARACTERS OUT)

'A' IS A CHARACTER ARRAY.
RESULT : A CHARACTER ARRAY OF THE SAME SIZE AND SHAPE AS 'A'. IT CONTAINS THE EBCDIC CHARACTERS WHICH ARE EQUIVALENT TO THE APL CHARACTERS IN 'A'. TRANSLATION IS PERFORMED USING THE GLOBAL VARIABLE 'ZC'.

A←CCI C (APL/CMS PRPQ CHARACTERS IN)

'C' IS A CHARACTER ARRAY.
RESULT : A CHARACTER ARRAY OF THE SAME SIZE AND SHAPE AS 'C'. IT CONTAINS THE APL CHARACTERS WHICH ARE EQUIVALENT TO THE Z-CODES USED IN THE APL/CMS PRPQ WHICH ARE REPRESENTED IN 'C'. THIS FUNCTION IS USED WHEN READING FILES CREATED UNDER THE APL/CMS PRPQ, AND WHERE CHARACTER DATA WAS STORED AS Z-CODES. TRANSLATION IS PERFORMED USING THE GLOBAL VARIABLE 'CZTNZ'. ('CZTNZ' IS A 256 CHARACTER VECTOR WHICH IF INDEXED WITH AN APL/CMS Z-CODE VALUE GIVES A UNIQUE APL CHARACTER CODE.)

C←CCO A (APL/CMS PRPQ CHARACTERS OUT)

'A' IS A CHARACTER ARRAY.
RESULT : A CHARACTER ARRAY OF THE SAME SIZE AND SHAPE AS 'A'. IT CONTAINS THE APL/CMS PRPQ Z-CODES WHICH ARE EQUIVALENT TO THE APL CHARACTERS IN 'A'. TRANSLATION IS PERFORMED USING THE GLOBAL VARIABLE 'CZTNZ'.

F←FI C (FLOATING IN)

'C' IS A CHARACTER ARRAY, THE LAST COORDINATE OF WHICH MUST HAVE A LENGTH OF 4 OR 8. THE LAST COORDINATE THUS REPRESENTS EITHER SINGLE OR DOUBLE PRECISION SYSTEM/370 FLOATING POINT NUMBERS.
RESULT : AN ARRAY OF NUMBERS EQUIVALENT TO THE FLOATING POINT REPRESENTATIONS IN 'C'. THE RANK OF 'F' IS ONE LESS THAN THE RANK OF 'C'.

```
ρF←→¯1↓ρC
```

C←FO F (FLOATING OUT)

'F' IS A NUMERIC ARRAY.
RESULT : A CHARACTER ARRAY WHOSE LAST COORDINATE HAS A LENGTH OF 8, AND WHICH CONTAINS THE SYSTEM/370 DOUBLE PRECISION FLOATING POINT REPRESENTATIONS OF THE NUMBERS IN 'F'. THE RANK OF 'C' IS ONE GREATER THAN THE RANK OF 'F'. IF SINGLE PRECISION IS REQUIRED THEN DROP THE LAST FOUR COLUMNS OF THE RESULT.

```
ρC←→(ρF),8
```

I←II C (INTEGERS IN)

'C' IS A CHARACTER ARRAY WHOSE LAST COORDINATE MUST HAVE A LENGTH OF BETWEEN 1 AND 7 INCLUSIVE, AND WHICH CONTAINS THE SYSTEM/370 BINARY REPRESENTATIONS OF INTEGERS. THE LIMIT OF 7 CHARACTERS OR 56 BITS IS THE MAXIMUM PRECISION REPRESENTABLE IN VS APL.
RESULT : AN ARRAY OF INTEGERS REPRESENTING THE BINARY NUMBERS IN 'C'. THE RANK OF 'I' IS ONE LESS THAN THE RANK OF 'C'.

```
ρI←→¯1↓ρC
```

C←N IO I (INTEGERS OUT)

'I' IS AN ARRAY OF INTEGERS.
'N' IS AN INTEGER SCALAR NOT GREATER THAN 7. IT GIVES THE NUMBER OF BYTES IN WHICH EACH INTEGER IS TO BE REPRESENTED. 'N' MUST BE LARGE ENOUGH TO REPRESENT THE LARGEST MAGNITUDE OF THE INTEGERS IN 'I'.
RESULT : A CHARACTER ARRAY WHOSE LAST COORDINATE CONTAINS THE SYSTEM/370 BINARY REPRESENTATIONS OF THE INTEGERS IN 'I'.

THE RANK OF 'C' IS ONE GREATER THAN THE RANK OF 'I'.

```
      ⍴C←→(⍴I),N
```

L←LI C (LOGICAL IN)

'C' IS A CHARACTER ARRAY WHOSE LAST COORDINATE CONTAINS SYSTEM/370 LOGICAL DATA OR A STRING OF BOOLEAN BITS.
RESULT : A NUMERIC ARRAY CONSISTING OF ZEROS OR ONES REPRESENTING THE LOGICAL DATA IN 'C'. THE RANK OF 'L' IS THE SAME AS THE RANK OF 'C', BUT THE LAST COORDINATE OF 'L' IS 8 TIMES AS LONG AS THE LAST COORDINATE OF 'C'. A SCALAR VALUE FOR 'C' PRODUCES AN EIGHT ELEMENT VECTOR.

```
      ⍴L←→(¯1↓⍴C),8×¯1↑1,⍴C
```

C←LO L (LOGICAL OUT)

'L' IS A NUMERIC ARRAY CONSISTING OF ONLY ZEROS AND ONES. THE LENGTH OF ITS LAST COORDINATE MUST BE A MULTIPLE OF 8.
RESULT : A CHARACTER ARRAY WHOSE LAST COORDINATE CONTAINS THE SYSTEM/370 REPRESENTATION OF THE LOGICAL DATA IN THE LAST COORDINATE OF 'L'. THE RANK OF 'C' IS THE SAME AS THE RANK OF 'L', BUT THE LENGTH OF THE LAST COORDINATE OF 'C' IS ONE-EIGHTH OF THE LENGTH OF THE LAST COORDINATE OF 'L'.

```
      ⍴C←→(¯1↓⍴L),(¯1↑⍴C)÷8
```

I←PDI C (PACKED DECIMAL IN)

'C' IS A CHARACTER ARRAY WHOSE LAST COORDINATE MUST HAVE A LENGTH OF BETWEEN 1 AND 16 INCLUSIVE, AND WHICH CONTAINS THE VALID SYSTEM/370 PACKED DECIMAL REPRESENTATION OF INTEGERS.
RESULT : AN ARRAY OF INTEGERS REPRESENTING THE PACKED DECIMAL NUMBERS IN 'C'. THE RANK OF 'I' IS ONE LESS THAN THE RANK OF 'C'.

```
      ⍴I←→¯1↓⍴C
```

NOTE THAT IF THE LENGTH OF THE PACKED DECIMAL NUMBERS IS GREATER THAN 9 BYTES, THEN A LOSS OF PRECISION MAY RESULT.

C←N PDO I (PACKED DECIMAL OUT)

'I' IS AN ARRAY OF INTEGERS.
'N' IS AN INTEGER SCALAR NOT GREATER THAN 16. IT GIVES THE NUMBER OF BYTES IN WHICH EACH INTEGER IS TO BE REPRESENTED. 'N' MUST BE LARGE ENOUGH TO REPRESENT THE LARGEST MAGNITUDE OF THE INTEGERS IN 'I'.
RESULT : A CHARACTER ARRAY WHOSE LAST COORDINATE CONTAINS THE SYSTEM/370 PACKED DECIMAL REPRESENTATIONS OF THE INTEGERS IN 'I'. THE RANK OF 'C' IS ONE GREATER THAN THE RANK OF 'I'.

```
      ⍴C←→(⍴I),N
```

'DATACVGP' IS THE NAME OF THE GROUP CONTAINING THE OBJECTS RELATED TO SUPPORT OF CONVERSION OF SYSTEM/370 INTERNAL DATA FORMATS.

LIB 2 PRINT
IBM DISTRIBUTED

THIS WORKSPACE (2 PRINT) CONTAINS PROGRAMS FOR TRANSMITTING APL PROGRAMS AND DATA TO THE OFFLINE PRINTER USING THE APL PRINT TRAIN. THESE PROGRAMS ARE ORGANIZED SO THAT YOU CAN EASILY MODIFY THEM TO SUIT YOUR SPECIFIC NEEDS. THE PRINCIPAL FUNCTIONS ARE 'PRINT' WHICH PRINTS TEXT, AND 'PRINTF' WHICH PRINTS FUNCTIONS.

THERE ARE TWO APL PRINT TRAINS AVAILABLE. TRAIN NUMBER RPQ-S00232 CONTAINS THE APL CHARACTER SET PLUS SOME SPECIAL NON-APL CHARACTERS AND PRINTS AT A FASTER RATE. TRAIN NUMBER RPQ-S00233 CONTAINS, IN ADDITION TO THIS, UPPER AND LOWER CASE ROMAN LETTERS. TO USE THESE TRAINS IT IS NECESSARY TO LOAD THE PRINTER CONTROL BUFFER WITH THE PROPER CONTROL PATTERNS. THIS FUNCTION IS CARRIED OUT BY THE MACHINE-ROOM OPERATOR WHEN HE MOUNTS THE PRINT TRAIN. THE NECESSARY CONTROL PATTERNS ARE GIVEN IN 'UCSFULL' AND 'UCSFAST'.

ANYTHING THAT CAN BE PRINTED ON THE FAST TRAIN CAN ALSO BE PRINTED ON THE FULL TRAIN.

THIS WORKSPACE CONTAINS EXTENSIVE DESCRIPTIVE MATERIAL, INCLUDING PROGRAMS FOR PUNCHING THE BUFFER LOAD IF THAT IS DESIRED, AND A COMPLETE DESCRIPTION OF THE ENCODINGS OF EACH OF THE CHARACTERS (IN THE VARIABLE 'HOWENCODED'). THESE ARE NOT NEEDED FOR OPERATION OF THE WORKSPACE, AND IT IIS RECOMMENDED THAT THEY BE ERASED (BY THE COMMAND ')ERASE DESCRIPTIVE') BEFORE USING THE WORKSPACE, AND BEFORE RUNNING THE TEST PROGRAM 'VALIDATE'.

THE PROGRAMS AND VARIABLES NEEDED TO USE THE PRINT FUNCTIONS ARE GROUPED UNDER THE NAME 'PRINTER' AND MAY BE COPIED INTO A WORKSPACE FOR USE.

```
      I PRINT M
```

PRINTS THE DATA IDENTIFIED IN THE RIGHT ARGUMENT M ACCORDING TO THE MODE CONTROL CONTAINED IN THE LEFT ARGUMENT I.

THE VALUE OF THE OBJECT (OR EXPRESSION) NAMED IN EACH ROW OF M IS PRINTED. IF A ROW OF M IS ENCLOSED IN QUOTES, THEN THE TEXT WITHIN THE QUOTES IS PRINTED. FOR EXAMPLE, IF M IS THE MATRIX

```
      'TEXT'
      TEXT
      ⍴TEXT
```

THEN THE EXPRESSION 1 PRINT M WILL CAUSE PRINTING FIRST OF A LINE CONTAINING THE FOUR CHARACTERS 'TEXT', THEN A DISPLAY OF WHATEVER

VALUE THE VARIABLE TEXT NOW HAS, AND FINALLY A LINE CONTAINING THE CHARACTERS THAT REPRESENT THE LENGTH OF THE VARIABLE TEXT.

ALTERNATIVELY, INSTEAD OF A MATRIX OF SUCCESSIVE ITEMS, THE RIGHT ARGUMENT M MAY BE A CHARACTER VECTOR IN WHICH THE SUCCESSIVE ITEMS ARE SEPARATED BY THE DELIMITING CHARACTER (THE VALUE OF THE GLOBAL VARIABLE DELIM). HENCE THE SAME RESULT COULD BE PRODUCED BY THE EXPRESSION

```
1 PRINT '''TEXT'';TEXT;⍴TEXT'
```

THE DELIMITER COULD BE A SPACE... BUT IN THAT CASE, OF COURSE, NO ITEM COULD CONTAIN A BLANK SPACE WITHIN IT.

THE LEFT ARGUMENT I SHOWS THE MODE-SWITCHING CHARACTER. IF MODE-SWITCHING IS NOT REQUIRED, THE LEFT ARGUMENT SHOULD BE A NUMERIC 1, AS SHOWN IN THE PRECEDING EXAMPLES.

IF THE LEFT ARGUMENT IS A CHARACTER, WHENEVER THAT CHARACTER IS ENCOUNTERED IN THE COURSE OF PRINTING, THE CURRENT MODE WILL BE REVERSED. THE MODE IS INITIALLY APL.

IF THE LEFT ARGUMENT CONTAINS TWO ELEMENTS, THE ITEMS TO BE PRINTED ARE SORTED INTO ALPHABETICAL ORDER BEFORE PRINTING. IT DOESN'T MATTER WHAT VALUE THE SECOND ELEMENT HAS.

CHARACTER DATA PRINTED BY THE PRINT FUNCTION MAY CONTAIN THE BACKSPACE CHARACTER (PRESENT IN THE WORKSPACE AS THE GLOBAL VARIABLE BSP). BY INSERTING BACKSPACES, YOU MAY CAUSE A GIVEN PRINT POSITION TO BE PRINTED TWICE (BUT NOT MORE). BACKSPACING PAST THE BEGINNING OF A LINE IS IGNORED. THE USE OF EXPLICIT BACKSPACES IS REQUIRED ONLY TO FORM CHARACTERS NOT PART OF THE APL CHARACTER SET; BACKSPACING TO FORM STANDARD CHARACTERS, SUCH AS ⍰ OR ⌽, IS PROVIDED AUTOMATICALLY BY THE PRINT FUNCTION. NOTE HOWEVER THAN IN TEXT MODE SOME OF THESE CHARACTERS ARE USED TO PRODUCE SPECIAL SYMBOLS SUCH AS THE DOLLAR SIGN, THE POUND SIGN, AND SO ON.

THE GLOBAL VARIABLE WIDTH ESTABLISHES THE LONGEST LINE TO BE PRINTED, JUST AS ⎕PW DOES IN DISPLAY TO THE TERMINAL. THE MAXIMUM PRINTING WIDTH PHYSICALLY AVAILABLE IS 130 CHARACTERS. LINES EXCEEDING THAT LENGTH ARE FOLDED, WITH THE CONTINUATION INDENTED BY SIX SPACES.

IN THE SCRIPT MODE THE MAPPING IS AS FOLLOWS:

A-Z MAPS INTO LOWER CASE ROMAN A-Z	⍰ MAPS TO PERCENT-SIGN
⍺-⍳ MAPS INTO UPPER CASE ROMAN A-Z	⍞ MAPS TO POUND-SIGN
	⍵ MAPS TO AT-SIGN
⊂ MAPS TO CENT-SIGN	' MAPS TO QUOTE
⍋ MAPS TO AMPERSAND	⍒ MAPS TO LAMBDA

φ MAPS TO DOLLAR-SIGN
~ MAPS TO NOT-SIGN
▼ MAPS TO LEFT-BUMPER
▲ MAPS TO RIGHT-BUMPER
THE REMAINING CHARACTERS MAP TO THEMSELVES.

```
 N PRINTF M
```

PRINTS THE FUNCTIONS NAMED IN MATRIX 'M'. ('M' CAN ALSO BE A VECTOR OF NAMES, EACH SEPARATED FROM ANOTHER BY ONE OR MORE BLANKS.) 'N' CONSISTS OF THREE ELEMENTS.

N[0] = PAGE LENGTH (N[0]≥30)
N[1] = PAGE WIDTH (30≤N[1]≤130) DEFAULTS TO ⎕PW IF OMITTED.
N[2] ≠ 0 IF FUNCTIONS ARE TO BE PRINTED IN ALPHABETIC ORDER.
= 0 (DEFAULT VALUE) TO PRINT FUNCTIONS IN THE ORDER NAMED.

YOU WILL BE PROMPTED TO ENTER A ONE-LINE PAGE HEADING. THE OUTPUT WILL BEGIN WITH AN INDEX OF THE FUNCTIONS LISTED. THE PAGES WILL BE NUMBERED. THE NAME OF EACH FUNCTION LISTED WILL BE PRINTED FLUSH WITH THE RIGHT MARGIN FOR READY IDENTIFICATION. A FUNCTION WILL BE SPLIT ACROSS TWO PAGES ONLY IF AT LEAST 5 LINES WILL APPEAR ON BOTH PAGES. THE GLOBAL VARIABLE 'PSPLIT' CONTROLS THIS. IT CONTAINS TWO NUMBERS, THE NUMBER OF LINES REQUIRED ON EACH PAGE BEFORE SPLITTING IS ALLOWED. TO PREVENT SPLITTING OF ANY FUNCTION DO 'PSPLIT←100 100'.

THE FOLLOWING GLOBAL VARIABLES PROVIDE PRINT OPTIONS. ASSIGN THE DESIRED VALUES TO THEM PRIOR TO EXECUTING PRINT OR PRINTF.

VARIABLE	DEFAULT	MEANING
PRINDENT	0	NUMBER OF POSITIONS TO INDENT OUTPUT
PRCLS	Z	PRINTER SPOOL CLASS
PRCPY	1	NUMBER OF COPIES TO BE PRINTED

FIVE SUB-FUNCTIONS ARE USED BY 'PRINT' AND 'PRINTF'. YOU CAN USE THESE TO BUILD YOUR OWN PRINTER-WRITING FUNCTIONS. THEY ARE 'QPEN', 'CLOSE', 'LINEOUT', 'OUTM', AND 'ΔCR'. EACH OF THESE FUNCTIONS RETURNS AN EMPTY VECTOR IF THEY PERFORM WITHOUT ERROR, AND ISSUE AN ERROR MESSAGE AND RETURN A VALUE OF ZERO IF SOMETHING GOES WRONG. THE FOLLOWING CALL DISCIPLINE IS USUALLY CONVENIENT:

```
→FUNC      EXITS FROM THE CALLER WHEN AN ERROR OCCURS.
→X←FUNC    BRANCHES TO X ON AN ERROR CONDITION.
```

```
 Z←QPEN
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QPEN INITIALIZES A VIRTUAL PRINTER NAMED 'APLPRT' TO RECEIVE YOUR OUTPUT. IT THEN INITIATES SHARING OF VARIABLES 'CMS' (CMS COMMUNICATION), 'OUTLINE' (THE OUTPUT RECORD VARIABLE) AND 'OUTLC' (THE OUTPUT CONTROL VARIABLE) WHICH ARE CONNECTED TO 'APLPRT'. THESE VARIABLES SHOULD BE DECLARED LOCAL TO THE CALLER OF 'QPEN'.

```
 Z←CLOSE
```

CLOSE DIRECTS THE VIRTUAL PRINTER TO TRANSMIT TO THE OUTPUT CLASS SPECIFIED BY 'PRCLS' SO THAT THE MACHINE-ROOM OPERATOR CAN SEND IT TO THE PRINTER WHEN THE APL PRINT-TRAIN IS INSTALLED. IT THEN RETRACTS THE SHARING OF VARIABLES SET UP BY OPEN. THIS AUTOMATICALLY RESULTS IN THE CLOSING OF THE VIRTUAL PRINTER. IF ALL GOES WELL IT TYPES A MESSAGE TO YOU THAT THE OUTPUT HAS BEEN SENT TO THE SPECIFIED CLASS. ONCE THE PRINTER IS CLOSED, THE PRINTER CLASS IS RESET TO A, THE NORMAL CLASS. NOTE THAT YOUR INSTALLATION MAY HAVE A DIFFERENT PRINTER CLASS FOR APL OUTPUT. IF SO YOU WILL HAVE TO MODIFY 'CLOSE' ACCORDINGLY.

```
Z←M LINEOUT L
```

LINEOUT ACCEPTS A VECTOR, 'L' TRANSLATES IT TO THE PROPER OUTPUT CODES AND SENDS IT TO THE PRINTER. LINEOUT PERFORMS MODE SWITCHING, BACKSPACE CHARACTER INTERPRETATION, AND LINE FOLDING. THE ARGUMENT 'M' IS THE MODE SWITCH CHARACTER. IF 2=⍴M A PAGE EJECT IS FORCED. NOTE THAT IT IS THE RESPONSIBILITY OF THE CALLER OF 'LINEOUT' TO MAINTAIN LINE COUNTS FOR 'AUTOMATIC' PAGE EJECTION.

'LINEOUT' REFERS TO THE GLOBAL VARIABLES 'ALFA' AND 'TRA'. THE VECTOR ALFA CONTAINS ALL CHARACTERS THAT THE PRINTER PROGRAM RECOGNIZES. THE ENCODING FOR EACH IS SHOWN IN MATRIX TRA. TO FIND THE ENCODING USED FOR A PARTICULAR CHARACTER X, FIND ITS POSITION IN THE REFERENCE VECTOR ALFA, AND USE THAT TO SELECT A COLUMN FROM TRA:

```
TRA[;ALFA⍳X]
```

ROWS 0 AND 3 OF TRA SHOW THE ENCODING USED FOR THE NORMAL MODE, AND ROWS 1 AND 3 SHOW THE ENCODINGS USED FOR THE ALTERNATE OR TEXT MORE. THE CODE 64 INDICATES A BLANK. FOR EACH CHARACTER THAT REQUIRES NO OVERSTRIKING, THE COMPANION CODE WILL BE 64.

THE TABLE MAY BE EXAMINED BY DISPLAYING

```
(135↑ALFA),⍪⍉TRA
```

NOTICE THAT THE LAST COLUMN OF TRA CONTAINS THE DEFAULT CODES TO BE PRINTED FOR ANY CHARACTERS THAT CANNOT BE FOUND IN ALFA.

```
Z←OUTM M
```

OUTM PUTS OUT MULTIPLE LINES OF TEXT IN THE 'APL' MODE. IT WILL ACCEPT A TEXT VECTOR OR CHARACTER ARRAY OF ANY DIMENSION. IT DOES NOT HANDLE BACKSPACE CHARACTERS, MODE-SWITCHING OR LINE FOLDING. (NORMAL APL OVERSTRUCK CHARACTERS SUCH AS ⌽ ARE OK.) LINES THAT ARE TOO LONG ARE TRUNCATED. IT DOES, HOWEVER, SUPPORT PAGINATION, TAKING ITS DIRECTION FROM FOUR GLOBAL VARIABLES, 'T', 'S', 'I', AND 'N'. 'T' IS THE PAGE HEADING AND 'S' IS THE PAGE

NUMBER. 'N' IS THE PAGE LENGTH, AND 'I' CONTAINS THE NUMBER OF LINES REMAINING AVAILABLE ON A PAGE. IF I=N+1 IT WILL CAUSE A PAGE EJECT. IF I=N-1 IT WILL CAUSE A DOUBLE SPACE BEFORE PRINTING THE FIRST LINE OF 'M'.

```
      Z←N ⎕CR V
```

⎕CR FORMATS THE FUNCTION NAMED IN 'V' INTO A MATRIX (RETURNED IN 'Z'). THE FORMATTING IS LIKE THAT PERFORMED BY THE APL EDITOR (OPENING AND CLOSING ∇ AND [...] LINE NUMBERS ARE APPENDED). 'N' SPECIFIES THE WIDTH (N≥30) WHICH MUST NOT BE EXCEEDED. LINES ARE FOLDED AND INDENTED 6 CHARACTERS IF THEY EXCEED THIS WIDTH. THE OUTPUT WILL NOT BE ANY WIDER THAN NECESSARY HOWEVER.

LIB 2 VSAMFNS
IBM DISTRIBUTED

THIS WORKSPACE CONTAINS FUNCTIONS THAT SUPPORT THE ACCESS OF EXTERNAL VSAM FILES.

THE FUNCTIONS ARE DESIGNED TO MEET THE MOST COMMON NEEDS AND THUS MAY NOT SERVE A PARTICULAR USERS REQUIREMENT. FOR THIS REASON NO FUNCTION IS LOCKED AND, IF NECESSARY, A USER MAY MODIFY A FUNCTION TO BETTER SUIT HIS PROBLEM.

ALTHOUGH THEY WILL SERVE MOST NEEDS WITHOUT ALTERATION, THESE FUNCTIONS SHOULD PROPERLY BE THOUGHT OF AS MODELS TO BE USED AS ONE SEES FIT. FOR EXAMPLE, THEY MAY NOT INSPECT ARGUMENTS FOR SHAPE, TYPE, ETC. IF THE USER WISHES SUCH DIAGNOSTICS HE MAY ADD THEM HIMSELF.

FOR ENTRY SEQUENCED AND KEY SEQUENCED VSAM FILES, FUNCTIONS ARE PROVIDED FOR SEQUENTIAL READING, DIRECT READING, WRITING, AND UPDATING. RECORDS APPEAR IN THE APL WORKSPACE AS CHARACTER VECTORS WHOSE ELEMENTS ARE AN EXACT COPY OF THE BYTES OF THE VSAM RECORDS. OTHER FUNCTIONS ERASE RECORDS AND POSITION A POINTER FOR THE START OF SEQUENTIAL OPERATIONS.

-USING INFORMATION

USE FN

'FN' IS A CHARACTER VECTOR CONTAINING A FILE NAME.
RESULT : THERE IS NO EXPLICIT RESULT. THE CONTENTS OF 'FN' ARE STORED IN THE GLOBAL VARIABLE '<u>FN</u>' AND THUS THE REFERENCED FILE BECOMES THE CURRENTLY SELECTED FILE. APPLICATIONS INVOLVING MULTIPLE FILES CAN USE THIS FUNCTION BETWEEN USES OF FILE ACCESS FUNCTIONS.

R←VREAD

RESULT : THE EXPLICIT RESULT IS THE RETRIEVED RECORD WHICH IS ALWAYS AN APL CHARACTER VECTOR. THE CURRENTLY SELECTED FILE (AS DEFINED IN '<u>FN</u>') IS OPENED FOR READING (IF NOT ALREADY OPEN). THE NEXT RECORD IN SEQUENCE IS READ. WHEN FIRST OPENED THE NEXT RECORD IS THE FIRST RECORD. THE POSITION OF THE NEXT RECORD IN A KEY SEQUENCED FILE CAN BE CHANGED BY USE OF THE 'VPOSITION', 'VGET', 'VGETHOLD' OR 'VSET' FUNCTIONS. IF THE RESULT IS AN EMPTY VECTOR THEN THE END OF FILE HAS BEEN REACHED AND THE FILE IS CLOSED. TO CLOSE THE FILE PRIOR TO REACHING THE END, USE THE FUNCTION 'CLOSE'.

R←VREADHOLD

SIMILAR TO 'VREAD' EXCEPT THAT THE FILE IS OPENED FOR UPDATE. 'VREADHOLD' IS USED IN CONJUNCTION WITH 'VSET' FOR UPDATING EXISTING RECORDS IN A FILE.

R←VGET KEY

'KEY' IS A CHARACTER VECTOR CONTAINING THE VSAM KEY FOR THE DESIRED RECORD. THE KEY MUST MATCH THE KEY LENGTH OF THE DEFINED FILE. IT IS CONSTRUCTED USING ⎕AV OR THE DATA CONVERSION FUNCTIONS IN THIS WORKSPACE AS APPROPRIATE SO IT MATCHES THE BIT PATTERN OF THE KEY IN THE FILE.
RESULT : THE EXPLICIT RESULT IS THE RETRIEVED RECORD WHICH IS ALWAYS AN APL CHARACTER VECTOR. THE CURRENTLY SELECTED FILE IS OPENED FOR READING (IF NOT ALREADY OPEN). IT MUST BE A VSAM KEY SEQUENCED DATA SET.

R←VGETHOLD KEY

SIMILAR TO 'VGET' EXCEPT THAT THE FILE IS OPENED FOR UPDATE. 'VGETHOLD' IS USED IN CONJUNCTION WITH 'VSET' FOR UPDATING EXISTING RECORDS IN A FILE.

VSET A

'A' IS A CHARACTER VECTOR AND REPRESENTS THE RECORD TO BE WRITTEN INTO THE FILE. FOR AN ENTRY SEQUENCED FILE THE RECORD IS ADDED TO THE END OF THE FILE. FOR A KEY SEQUENCED FILE THE KEY MUST BE APPROPRIATELY IMBEDDED IN THE RECORD. NO TRANSLATING IS PERFORMED AND 'A' MUST BE CONSTRUCTED USING THE DATA CONVERSION FUNCTIONS AS APPROPRIATE.
RESULT : THERE IS NO EXPLICIT RESULT. THE CURRENTLY SELECTED FILE IS OPENED FOR WRITING (IF NOT ALREADY OPEN FOR WRITING OR UPDATING). THE CONTENTS OF 'A' ARE WRITTEN INTO THE CURRENTLY SELECTED FILE. IF UPDATING AN EXISTING RECORD THEN THE PREVIOUS OPERATION MUST HAVE BEEN A 'VREADHOLD' OR A 'VGETHOLD' OF THE SAME RECORD. IF UPDATING AN ENTRY SEQUENCED FILE, THE NEW RECORD MUST NOT BE LONGER THAN THE RECORD BEING REPLACED.

VERASE KEY

'KEY' IS A CHARACTER VECTOR CONTAINING THE KEY OF THE RECORD TO BE ERASED.
RESULT : THERE IS NO EXPLICIT RESULT. THE CURRENTLY SELECTED FILE IS OPENED FOR UPDATING (IF NOT ALREADY OPEN FOR UPDATING). THE REFERENCED RECORD IN THE CURRENTLY SELECTED VSAM KEY SEQUENCED FILE IS ERASED.

VPOSITION KEY

'KEY' IS A CHARACTER VECTOR CONTAINING THE KEY OF THE CHOSEN RECORD. IF 'KEY' IS AN EMPTY VECTOR THEN THE FIRST RECORD IN THE FILE IS SELECTED.

RESULT : THERE IS NO EXPLICIT RESULT. THE CURRENTLY SELECTED FILE IS OPENED FOR READING (IF NOT ALREADY OPEN). A POINTER IS SET AT THE BEGINNING OF THE SELECTED RECORD AND PROVIDES A STARTING POINT FOR THE NEXT SEQUENTIAL READ OPERATION.

CLOSE

RESULT : THERE IS NO EXPLICIT RESULT. THE CURRENTLY SELECTED FILE IS CLOSED AND ITS ASSOCIATED SHARED VARIABLES EXPUNGED.

'VSAMGP' IS THE NAME OF THE GROUP CONTAINING OBJECTS RELATED TO SUPPORT OF EXTERNAL VSAM FILES.

'READVSAMGP' IS THE NAME OF THE GROUP WHICH IS A SUBSET OF 'VSAMGP' AND WHICH CONTAINS OBJECTS NEEDED FOR READ ONLY ACCESS TO EXTERNAL VSAM FILES.

IF AN ERROR CODE (OTHER THAN ZERO) IS RETURNED FROM AUXILIARY PROCESSOR NO. 123, THEN THE APPROPRIATE ERROR MESSAGE IS PRINTED, AND EXECUTION IS TERMINATED WITH A 'SYNTAX ERROR' IN THE FUNCTION 'CHK'. IT IS RECOMMENDED THAT 'CHK' BE LOCKED IN ACTUAL USE SO A 'DOMAIN ERROR' WILL POINT TO 'CHK'.

AN OPTION IS PROVIDED WHERE IF THE VARIABLE 'CLEARSW' IS SET TO 1 INSTEAD OF 0, THEN AFTER PRINTING THE AUXILIARY PROCESSOR ERROR MESSAGE, THE STACK WILL BE CLEARED AND ALL NON-SHADOWED SHARED VARIABLES RETRACTED, WITHOUT ANY 'SYNTAX' OR 'DOMAIN' ERRORS.

SPECIAL HANDLING OF SELECTED ERRORS

ANOTHER OPTION PROVIDES FOR APPLICATIONS TO HANDLE SELECTED ERROR RETURN CODES BY SPECIAL PROGRAMMING WITHOUT THE FUNCTIONS PRINTING ANY ERROR MESSAGES AND WITHOUT SUSPENDING EXECUTION.

TO USE THIS FACILITY THE APPLICATION SHOULD INSERT INTO THE GLOBAL VARIABLE 'PCODES' A NON-EMPTY VECTOR OF AP RETURN CODES WHICH THE APPLICATION WILL HANDLE BY SPECIAL PROGRAMMING. THE ACTUAL RETURN CODE GIVEN BY THE AUXILIARY PROCESSOR CAN ALWAYS BE FOUND IN THE GLOBAL VARIABLE 'RCODE' WHICH CAN BE REFERENCED BY THE APPLICATION. 'RCODE' ALWAYS CONTAINS EITHER A ZERO, A RETURN CODE FROM 'PCODES' OR ONE OF THE RETURN CODES HANDLED WITHIN THE WORKSPACE FUNCTIONS (SUCH AS THE END OF FILE CODE).

NOTE THAT A RETURN CODE FROM THE EXTERNAL VSAM AUXILIARY PROCESSOR CONSISTS OF A TWO ELEMENT VECTOR. SUCH A RETURN CODE IS

REPRESENTED IN 'PCODES' BY A SINGLE INTEGER OBTAINED BY ADDING THE SECOND ELEMENT TO 100000 *TIMES THE FIRST ELEMENT (I.E. BY* 100000⊥*C1 C2).*

IF ANY FUNCTION RECEIVES A RETURN CODE FROM THE AUXILIARY PROCESSOR WHICH IS CONTAINED IN 'PCODES' THEN THAT FUNCTION TERMINATES WITH THE ACTUAL RETURN CODE IN 'RCODE'. FOR FUNCTIONS WHICH GIVE AN EXPLICIT RESULT, THAT RESULT WILL BE THE EMPTY VECTOR.

THE DEFAULT VALUE OF 'PCODES' IS ANY IMPOSSIBLE VALUE SUCH AS ¯1. *BE CAREFUL NOT TO INCLUDE A ZERO IN 'PCODES' UNLESS FOR A VERY SPECIAL REASON. ALSO 'PCODES' SHOULD NEVER CONTAIN THE EMPTY VECTOR.*

LIB 3 APLDOC
15/5/78
P.PALAMIDESE

THIS WORKSPACE CONTAINS FUNCTIONS WHICH PROVIDE
YOU WITH THE COMPLETE DOCUMENTATION OF THE APL PUBLIC
LIBRARIES AVAILABLE AT CNUCE.

YOU HAVE AT DISPOSAL THE FOLLOWING COMMANDS:

HELP

LISTS ALL AVAILABLE COMMANDS IN WS 3 APLDOC
AND THEIR OPTIONS

LIBS

LISTS ALL IMPLEMENTED LIBRARIES WITH A FEW
WORDS OF DESCRIPTION

LIB N

LISTS ALL WORKSPACES IMPLEMENTED IN LIBRARY N

TYPE LIBNUM WSNAME [(ABS|ALL]

PRINTS OUT ON YOUR TERMINAL THE FULL DOCUMENTATION
OF WS LIBNUM WSNAME IF (ALL SPECIFIED,OTHERWISE
ONLY A FEW WORD OF DESCRIPTION ARE PRINTED. THE SYSTEM
PRINTS ONE PAGE AT A TIME (FIFTY LINES) AND STOPS. ENTER
AN EMPTY LINE TO CONTINUE EXECUTION.
THE DEFAULT OPTION IS (ABS.

PRINT LIBNUM WSNAME

PRINTS OFF-LINE THE DOCUMENTATION OF
THE WORKSPACE LIBNUM WSNAME

PRINT LIBNUM

PRINTS OFF-LINE THE FULL DOCUMENTATION OF
LIBRARY LIBNUM

PRINT ALL

PRINTS OFF-LINE ALL THE IMPLEMENTED
DOCUMENTATION OF THE APL PUBLIC LIBRARIES

END [APL|CMS]

THIS COMMAND IS USED TO EXIT FROM THE
APLDOC ENVIRONMENT AND TO GO IN THE
APL ENVIRONMENT OR IN THE CMS ENVIRONMENT
DEPENDING ON THE OPTION CHOSEN. THE
DEFAULT OPTION IS APL.

LIB 3 APLERF
G.FIORIO, IEI, PISA

THE FUNCTIONS ERF AND ERFC COMPUTE THE ERROR FUNCTION AND THE COMPLEMENTED ERROR FUNCTION EXACT TO AT LEAST 14 SIGNIFICANT DIGITS.

THE ARGUMENT X IS ANY SCALAR, VECTOR OR MATRIX OF ANY RANK, THE EXPLICIT RESULT HAVING THE SAME STRUCTURE AS THE ARGUMENT. THEY EMPLOY THE VARIABLE RP←→÷(○1).5 AND THE AUXILIARY FUNCTIONS SERF OR EXERFC DEPENDING ON THE VALUE OF THE ARGUMENT IN ORDER TO MINIMIZE THE ERROR. SINCE THE MAGNITUDE LIMITATION IS ABOUT 5.4E¯79, ERFC X IS SET EQUAL TO ZERO IF X≥13.306. HOWEVER IF (*X×X)×ERFC X NEEDS TO BE COMPUTED FOR X>13, USE EXERFC DIRECTLY.*

SYNTAX	*DESCRIPTION*
Z←ERF X	*COMPUTES ERF X*
Z←ERFC X	*COMPUTES 1-ERF X*
Z←SERF X	*COMPUTES (ERF X)×.5×(○1)*.5 BY MEANS OF THE ALTERNATE SIGNS SERIES UNTIL THE TERMS BECOME LESS THAN 3E¯17 TIMES THE PARTIAL SUM*
Z←REL EXERFC X	*COMPUTES (ERFC X)×(*X×X)×(○1)*.5 BY MEANS OF THE CONTINUED FRACTION UNTIL TWO SUCCESSIVE CONVERGENTS DIFFER BY A FRACTION LESS THAN REL*

LIB 3 CETEST
IBM DISTRIBUTED

THE FUNCTIONS IN THIS WORKSPACE MAY BE USED TO EXERCISE TERMINALS SUPPORTED BY VSAPL.

A LIST OF ALL FUNCTIONS PROVIDED AND A SAMPLE EXECUTION OF EACH IS OBTAINED BY TYPING

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TEST
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EACH FUNCTION LISTED BY TEST TAKES AN INTEGER ARGUMENT GIVING THE NUMBER TIMES THE TEST IS TO BE REPEATED. FOR EXAMPLE, FIVE BACKSPACE TESTS -

```
BST 5
```

LIB 3 XREF
IBM DISTRIBUTED

THIS WORKSPACE CONTAINS AN APL PROGRAM CROSS-REFERENCER (GROUP XREFER) AND TWO APL PROGRAM LISTERS (GROUP LISTER).

CROSS-REFERENCE FUNCTIONS:

XREF0	INITIALIZE CROSS REFERENCE TABLES
XREF	ADD CROSS REFERENCE INFORMATION
LISTREF	LIST CROSS REFERENCE INFORMATION ABOUT FUNCTIONS AND GLOBAL VARIABLES
LISTL	LIST CROSS REFERENCE INFORMATION AROUT LOCAL VARIABLES AND TAGS
SHOWREFS	PRODUCE FOR DISPLAY A COMPLETE CROSS REFERENCE MATRIX
TURNR	TRANSPOSE THE DISPLAY MATRIX
UNREF	REMOVE NAMES FROM THE CROSS REFERENCE INFORMATION
CLEANREF	REMOVE UNREFERENCED VARIABLES FROM THE CROSS REFERENCE DATA
STATS	DISPLAY STATISTICS ABOUT THE PROGRAMS BEING CROSS REFERENCED
TOPO	DISPLAY THE TOPOLOGICAL RELATIONSHIPS AMONG THE PROGRAMS
BROWSE	BROWSE A FUNCTION LOOKING FOR VARIOUS PATTERNS AND DISPLAYING THE LINES CONTAINING THEM

LISTER FUNCTIONS:

LISTF	LIST ONE OR MORE APL PROGRAMS
MAGC	LIST APL PROGRAMS IN A FORMAT FOR MAGNETIC CARDS

-USING INFORMATION

XREF ⍺: COLLECT CROSS-REFERENCE INFORMATION ABOUT FUNCTIONS LISTED IN ⍺. ⍺ CAN BE 'NAME1 NAME2 NAME3 ... ' OR A MATRIX OF NAMES (AS PRODUCED BY '⎕NL 3'). RECOMMENDED USE IS AS FOLLOWS:

```
XXX←⎕NL 3
)COPY 3 XREF XREFER
XREF XXX
```

AS PROCESSING TAKES PLACE THE FUNCTION NAMES WILL BE PRINTED AND YOU WILL BE INFORMED IF THERE ARE ANY UNREFERENCED LOCAL VARIABLES.

⍺ CAN ALSO TAKE THE FORM '+NAME1 NAME2 NAME3 ...' IN WHICH CASE THE FUNCTION 'NAME1' WILL BE ASSUMED TO REFERENCE NAME2 ETC. THIS IS USEFUL WHEN YOUR PROGRAMS REFER TO VARIABLES OR

OTHER FUNCTIONS INDIRECTLY THROUGH THE EXECUTE (⍎) OPERATOR OR THROUGH ⎕: INPUT.

XREF CAN BE USED REPEATEDLY TO ADD TO INFORMATION ALREADY COLLECTED, AND YOU CAN RE-CROSS-REFERENCE A FUNCTION AFTER YOU HAVE CHANGED IT. THE DATA THAT HOLDS THE CROSS REFERENCE INFORMATION IS GROUPED AS 'XDATA'. YOU CAN RESET THIS DATA EXPLICITLY BY USING THE FUNCTION 'XREF0' (IT HAS NO ARGUMENTS).

⍺ LISTREF ⍵: LIST GLOBAL VARIABLES AND THEIR REFERENTS (LIST ⍺) AND LIST FUNCTIONS (LIST ⍵), THEIR HEADER LINES, GLOBAL VARIABLE AND FUNCTION REFERENCES, AND THE FUNCTIONS THAT CALL THEM. THE LISTS ⍺ AND ⍵ CAN BE A QUOTED LIST OF NAMES -- 'NAME1 NAME2 ... ETC.', OR THE WORDS 'ALL' OR 'NONE'. IF YOU USE 'ALL' THE VARIABLES AND FUNCTIONS WILL BE LISTED IN ALPHABETICAL ORDER. OTHERWISE THEY WILL BE LISTED IN THE ORDER YOU GIVE.

STATS: REPORT STATISTICS ABOUT THE PROGRAMS CROSS-REFERENCED.

⍺ LISTL ⍵: LIST LOCAL VARIABLES AND THEIR USAGE. ⍺ IS THE LIST OF LOCAL VARIABLES (THOSE APPEARING IN THE FUNCTION HEADER). ⍵ IS THE LIST OF LINE LABELS (THOSE APPEARING PRECEDING A COLON IN SOME FUNCTION LINES). AS WITH LISTREF ⍺ AND ⍵ CAN BE QUOTED LISTS OF NAMES, OR CAN BE THE WORDS 'ALL' AND 'NONE'.

M←SHOWREFS: PRODUCE A CROSS-REFERENCE MATRIX AND RETURN IT AS A VALUE. THE VALUE RETURNED WILL BE A CHARACTER MATRIX WITH ALL NAMES USED IN THE PROGRAM LISTED DOWN ONE SIDE, AND THE FUNCTION NAMES LISTED ACROSS THE TOP. (THESE WILL BE DENOTED BY 'N' AND 'F' RESPECTIVELY.) ENTRIES IN THE MATRIX DENOTE WHICH NAME IS REFERENCED BY WHICH FUNCTION. THE TYPES OF REFERENCE ARE INDICATED AS FOLLOWS:

- G: GLOBAL REFERENCE
- L: LOCAL REFERENCE
- T: TAG (LINE LABEL)

THE LAST COLUMN IN THE MATRIX WILL CONTAIN A CODE INDICATING ALL OF THE WAYS IN WHICH A NAME WAS REFERENCED. THE FOLLOWING CODES ARE USED:

- •: NOT REFERENCED BY ANY FUNCTION
- T: TAG ONLY
- L: LOCAL ONLY
- G: GLOBAL ONLY
- B: BOTH TAG AND LOCAL
- O: GLOBAL AND TAG
- S: SEMI-GLOBAL (GLOBAL AND LOCAL)
- ×: GLOBAL, LOCAL, AND TAG

SHOULD BE IN THE MACHINE, AND SET AT LINE 1 BEFORE YOU START.) THE FUNCTION(S) WILL PRINT AND SIMULTANEOUSLY BE RECORDED UNTIL THE CARD IS FULL OR THE END OF ALL FUNCTIONS IS REACHED. WHEN THE END OF A CARD IS REACHED IT WILL AUTOMATICALLY BE EJECTED AND THE COMPUTER WILL PAUSE, WAITING FOR YOU TO ENTER AN EMPTY LINE. YOU REPLACE THE EJECTED CARD WITH THE NEXT ONE, PRESS THE 'PLAY' BUTTON ON THE LEFT OF THE TYPEWRITER, RETURN THE CARRIAGE, AND PRESS THE 'REC' BUTTON AS BEFORE. THIS PROCESS IS REPEATED UNTIL ALL OF THE FUNCTIONS HAVE BEEN RECORDED. IF THE FUNCTION COMPLETES BEFORE THE LAST CARD IS FILLED YOU HOLD DOWN THE 'CODE' BUTTON WHILE YOU PRESS THE 'EJECT' KEY (KEY 3) WHICH RECORDS AN EJECT CODE ON THE CARD AND EJECTS IT. ON COMPLETION OF RECORDING, PRESS THE 'PLAY' BUTTON TO RETURN THE TYPEWRITER TO ITS NORMAL MODE. YOU SHOULD BECOME FAMILIAR WITH THE FUNCTIONS OF THE MAGNETIC CARD SELECTRIC TYPEWRITER BEFORE USING THIS FUNCTION. (NOTE THAT 'MAGC α' IS EQUIVALENT TO '50 99 0 LISTF α' EXCEPT THAT LISTF DOES NOT STOP AT THE END OF A PAGE.)

Z←TURNR M: TRANSPOSE THE CROSS-REFERENCE MATRIX PRODUCED BY SHOWREFS.

UNREF α REMOVE THE NAMES LISTED IN QUOTED ARGUMENT, α, FROM THE CROSSREFERENCE DATA. IF A FUNCTION IS NAMED IT IS REMOVED ALONG WITH THOSE NAMES THAT ONLY IT REFERENCES.

CLEANREF REMOVES ALL UNREFERENCED VARIABLE NAMES FROM CROSSREFERENCE DATA.

TOPO: PRODUCE A LIST OF FUNCTIONS SHOWING THEIR CALL-NESTING RELATIONSHIPS. EACH FUNCTION WITH NO CALLER (I.E. ONES PRESUMABLY CALLED FROM THE KEYBOARD) ARE LISTED WITH A * IN FRONT OF THEM. ALL FUNCTIONS CALLED BY A GIVEN FUNCTION ARE LISTED BELOW IT, INDENTED AND PRECEDED BY A '∘'. VERTICAL BARS, '|', ARE USED AS AN EYE-ALIGNMENT AID TO CONNECT '∘' CHARACTERS VERTICALLY. EACH COLUMN OF '|' INDICATES ONE LEVEL OF CALL-NESTING. IF THE LIST SPANS A PAGE, THE COLUMNS ARE NUMBERED AT THE BOTTOM OF ONE PAGE AND THE TOP OF THE FOLLOWING PAGE FOR ALIGNMENT PURPOSES.

BROWSE 'α': BROWSE THE FUNCTION NAMED 'α'. THE KEYBOARD WILL UNLOCK TO RECEIVE A CHARACTER STRING. WHEN YOU ENTER IT, YOU WILL BE GIVEN THE LINE NUMBER(S), OF ANY LINE(S) FOUND IN THE FUNCTION WHICH CONTAIN THE STRING. IF THE STRING IS SUFFIXED BY A BLANK THE LINES WILL BE LISTED. IF YOU ENTER ONLY A SINGLE BLANK CHARACTER THE LINES FROM THE PREVIOUS SEARCH WILL BE PRINTED. IF YOU ENTER '[' ALL LINES WILL BE PRINTED. IF YOU ENTER AN EMPTY STRING, 'BROWSE' WILL TERMINATE.

∈1 ∈2 ∈3 ∈4 LISTF α: LIST THE APL FUNCTIONS NAMED IN THE LIST α. α CAN BE A MATRIX OF NAMES AS PRODUCED BY '⎕NL 3', OR CAN BE A CHARACTER VECTOR OF NAMES EACH SEPARATED BY ONE OR MORE BLANKS. THE FUNCTIONS ARE LISTED IN THE ORDER GIVEN ∈1 LINES PER PAGE, ∈2 CHARACTERS WIDE. $10 \le \in 1 \le 60$. $30 \le \in 2 \le ⎕PW$. ∈2 CAN BE OMITTED, AND IF IT IS, ∈2=⎕PW. IF ∈3 IS PRESENT AND $\in 3 \neq 0$ AND THE FUNCTIONS WILL BE LISTED IN ALPHABETICAL ORDER. IF ∈4 IS PRESENT AN D $\in 4 \neq 0$ THE POGRAM WILL STOP AT THE END OF EACH PAGE WAITING FOR AN EMPY LINE TO CONTINUE.

MAGC α: LIST THE APL FUNCTIONS NAMED IN LIST α IN A FORM SUITABLE FOR RECORDING ON MAGNETIC CARDS. THIS FUNCTION STOPS AT A PAGE-BREAK (I.E. END OF A MAGNETIC CARD) WAITING FOR YOU TO ENTER AN EMPTY LINE TO SIGNAL CONTINUATION. TO USE IT WITH A MAGNETIC CARD SELECTRIC TYPEWRITER YOU CALL THE FUNCTION. IMMEDIATELY AFTER YOU RETURN THE CARRIAGE (BEFORE THE COMPUTER CAN RESPOND) YOU PRESS THE 'REC' BUTTON ON THE LEFT SIDE OF THE TYPEWRITER. (NATURALLY, A MAGNETIC CARD

APLTEXT 4.1

LIB 4 APLTEXT
IBM DISTRIBUTED

APLTEXT IS A PACKAGE OF PROGRAMS FOR PROCESSING TEXT FROM WITHIN APL. THE PACKAGE IS FULLY DOCUMENTED IN 'AN APL T9EXT EDITOR AND COMPOSER PROGRAM DESCRIPTION/OPERATIONS MANUAL' - ORDER FORM SH20-1089-1.

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LIB 5 CALENDAR
E.ARMITAGE, COMPUTING CENTER, U. OF ALBERTA

THIS WS SOLVES THE PROBLEM OF RELATING DATES TO CALENDAR DAYS.

  THE FUNCTION 'CDATE' CONVERTS A DATE TO THE NUMBER OF
CALENDAR DAYS SINCE THE BEGINNING OF YEAR 1.  THE ARGUMENT IS A
DATE IN THE FORM OF A 3 ELEMENT VECTOR MM DD YYYY (OR IT CAN BE A
SCALAR IF THE ARGUMENT IS A VECTOR, OR A VECTOR  IF THE ARGUMENT
IS A MATRIX.  THE INVERSE FUNCTION IS 'CDAYS' WHICH CONVERTS THE
NUMBER OF DAYS SINCE THE BEGINNING OF YEAR 1 TO A CALENDAR DATE.
THE RESULT RETURNED BY 'CDAYS' IS A 3 ELEMENT VECTOR IF THE
ARGUMENT IS A SCALAR, OR A 3 COLUMN MATRIX IF THE ARGUMENT IS A
VECTOR.
      TO FIND THE DAY OF THE WEEK EXECUTE '7|CDATE DATE(S)' WHICH
WILL RETURN A DIGIT (OR DIGITS) 0 THRU 6 WHICH REPRESENTS THE
DAYS SUNDAY THRU SATURDAY.

SAMPLE APPLICATIONS :

     FIND THE EXPIRATION DATE OF A 120-DAY WARRANTY ASSUMING A
STARTING DATE OF 11/9/1971.

      CDAYS 120 + CDATE 11 9 1971
3  8  1972

      FIND THE NUMBER OF DAYS FROM 2/20/1971 TO 9/12/1971.

      -/CDATE 9 12 1971,[.1] 2 20 1971
204

      WHAT IS THE DATE OF LABOR DAY (FIRST MONDAY IN SEPTEMBER) IN
1984?

      CDAYS N+7|1-N+CDATE 9 1 1984
9  3  1984
```

LIB 5 GRADES
BARBARA STANLEY, PSYCHOLOGY DEPT, UNIV. OF ALBERTA

THIS FUNCTION CALCULATES THE TERM MARK, FINAL MARK, AND GRADE POINT MARK.

THE PROGRAM WILL ASK FOR ALL THE DATA IT NEEDS. FOR EACH EXAM A WEIGHT AND A SET OF MARKS (ONE FOR EACH STUDENT) MUST BE SUPPLIED. THE PROGRAM WILL CALCULATE A TERM MARK, A FINAL MARK AND A GRADE POINT MARK FOR EACH STUDENT. THE GRADE POINTS ARE ALLOCATED IN THE FOLLOWING PROPORTIONS:

1,9---4 *PERCENT EACH*
2,8---7 *PERCENT EACH*
3,7---12 *PERCENT EACH*
4,6---17 *PERCENT EACH*
5 ---20 *PERCENT*

THE SETS OF MARKS MUST BE SUCH THAT THE FIRST MARK ALWAYS REFERS TO THE FIRST STUDENT, THE SECOND MARK TO THE SECOND STUDENT, ETC. IF YOU WANT TO CALCULATE TERM MARKS AND GRADE POINTS FOR TERM MARKS WITHOUT INCLUDING FINAL EXAM RESULTS, ENTER A VECTOR OF ZEROES FOR THE LAST SET OF MARKS. THE CALCULATED TERM MARK AND GRADE POINTS WILL BE CORRECT BUT THE FINAL MARK WILL HAVE NO MEANING. ALL MARKS MUST BE OUT OF THE SAME TOTAL. (I.E. ALL GRADE POINTS, OR ALL PERCENTS, OR ALL OUT OF 200, ETC.) THE FINAL GRADE AND TERM GRADE WILL ALSO BE OUT OF THE SAME TOTAL.

LIB 5 DEMO
M.WILLARD; MATH.DEPT.; U. OF ALBERTA

DEMO IS A PACKAGE OF PROGRAMS WHICH DEMONSTRATE SOME OF APL'S CAPABILITIES.

TO RUN THE PROGRAM, THE USER NEED ONLY TYPE HI. THE PROGRAM ITSELF TELLS THE USER WHAT TO DO NEXT. THE PROGRAM IS NOT WRITTEN IN THE MOST CONCISE APL NOTATION POSSIBLE; THIS IS SO THAT IT CAN BE COPIED AND EASILY DISSECTED AND/OR MODIFIED TO SUIT THE USER'S PURPOSES.

LIB 5 INDIRIZZ
S. TRUMPY

LO SPAZIO DI LAVORO INDIRIZZ CONTIENE FUNZIONI PER LA GESTIONE DI INDIRIZZARI.

OGNI INDIRIZZARIO E' IDENTIFICATO DA UN NOME DI NON PIU' DI 10 CARATTERI E CONTIENE UN NUMERO DI INDIRIZZI VARIABILE CON LE DIMENSIONI DELLO SPAZIO DI LAVORO A DISPOSIZIONE.
OGNI INDIRIZZO PUO' ESSERE AL MASSIMO DI SEI RIGHE DI NON PIU' DI 32 CARATTERI.
LE FUNZIONI A DISPOSIZIONE DELL'UTILIZZATORE SONO:
AGGIUNGI, CANCELLA, CORREGGI, INIZIA, NOMI, PULISCI, STAMPA, SCASSA.

AGGIUNGI ARG
PERMETTE DI INSERIRE NUOVI INDIRIZZI NELL'INDIRIZZARIO 'ARG', NOTIFICANDO CON OPPORTUNI MESSAGGI GLI EVENTUALI ERRORI COMMESSI.

NUM CANCELLA ARG
PERMETTE DI CANCELLARE L'INDIRIZZO (GLI INGIRIZZI) CHE HA NUMERO D'ORDINE 'NUM' DALL'INDIRIZZARIO 'ARG'. DOPO OGNI CANCELLAZIONE L'ORDINAMENTO DELL'INDIRIZZARIO E' AUTOMATICAMENTE RICOMPOSTO. PONENDO NUM='TUTTI', VENGONO CANCELLATI TUTTI GLI INDIRIZZI DELL'INDIRIZZARIO 'ARG' CHE RESTA INIZIALIZZATO.

NUM CORREGGI ARG
PERMETTE DI CORREGGERE UNA O PIU' RIGHE DELL'INDIRIZZO CHE HA NUMERO D'ORDINE 'NUM' DELL'INDIRIZZARIO 'ARG', NOTIFICANDO EVENTUALI ERRORI COMMESSI.

INIZIA ARG
CREA UN NUOVO INDIRIZZARIO IDENTIFICATO DA 'ARG'

NOMI ARG
STAMPA TUTTI I NOMI CONTENUTI NELL'INDIRIZZARIO 'ARG' CON I RELATIVI NUMERI D'ORDINE.

PULISCI
CANCELLA TUTTI GLI INDIRIZZARI CONTENUTI NELLO SPAZIO DI LAVORO.

SCASSA ARG
CANCELLA L'INDIRIZZARIO 'ARG' DALLO SPAZIO DI LAVORO.

NUM STAMPA ARG
STAMPA L'INDIRIZZARIO (GLI INDIRIZZI) DEFINITI DA 'NUM' DELL'INDIRIZZARIO 'ARG'.

TUTTE LE FUNZIONI DESCRITTE SONO INSERITE NEL GRUPPO 'INDPAC'.

LIB 5 UTIL
E.M. EDWARDS;E.E. DEPT.;U. OF ALBERTA

THIS WS CONTAINS FUNCTIONS WHICH SUBSTITUTE SOME OPERATORS,MEASURE THE CPU TIME REQUIRED TO EXECUTE A FUNCTION,HELP YOU STRUCTURING REAL DATA.

R←X BAS C

BAS IS AN EXTENSION TO ⊥. IT PERMITS USE OF ANY DIMENSION ARGUMENTS.

(⍴R)←→(⍴X),(¯1↓⍴C)

THE POLYNOMIAL ((X*2)+(2×X)+1) MAY BE EVALUATED FOR

X=0 1 2 3 4 BY:

```
0 1 2 3 4 BAS 1 2 1
```

THE LAST DIMENSION OF C REPRESENTS COEFFICIENT ORDER.

R←X CAT Y

THE COLUMNS OF Y ARE ATTACHED TO X AS ADDITIONAL COLUMNS ON THE RIGHT. THE RANKS OF X AND Y MAY BE ANY VALUES THAT DO NOT DIFFER BY MORE THAN ONE.
RANKS EQUAL: ALL DIMENSIONS MUST BE EQUAL EXCEPT THE LAST.
RANKS DIFFER BY ONE: THE LOWER RANK STRUCTURE IS TAKEN AS A ONE COLUMN STRUCTURE AND USED AS ABOVE.

M←FORM V

FORM TAKES A SCALAR OR VECTOR V AND RETURNS A MATRIX OF LITERALS M. THE ELEMENTS OF M ARE DIGITS, DECIMAL POINTS, AND PLUS OR MINUS SIGNS. EACH ROW OF M REPRESENTS AN ELEMENT OF V AND CONTAINS N SIGNIFICANT FIGURES PLUS LEADING OR TRAILING ZEROS AND A DECIMAL POINT, IF NECESSARY. A COLUMN OF SIGNS IS ADDED ONLY IF ANY OF THE ELEMENTS OF V ARE NEGATIVE.

TIMER

TIMER IS USED TO MEASURE THE CPU TIME REQUIRED TO EXECUTE ONE OR MORE FUNCTIONS.
TIMER IGNORE THE RESULT PRINTED AT THIS TIME. EXECUTE THE FUNCTION(S) TO BE TESTED AND RE-EXECUTE TIMER. THE NUMBER PRINTED

OUT IS THE CPU TIME REQUIRED FOR ALL OPERATIONS SINCE THE PREVIOUS EXECUTION OF TIMER.

ENTERDATA

THIS IS A STRUCTURING PROGRAM WHICH ALLOWS ANY NUMBER OF REAL DATA SETS TO BE ENTERED ROW BY ROW IN A DATA MATRIX. THE DATA SETS DO NOT HAVE TO BE OF EQUAL LENGTH. THE PROGRAM 'ENTERDATA' WILL REQUEST INPUT FROM THE TERMINAL. IF THE INPUT IS TO BE TERMINATED TYPE: ⍬ . THE PROGRAM WILL GIVE A DIRECT OUTPUT UNLESS IT IS ASSIGNED TO A VARIABLE. THE FIRST COLUMN IN THE ARRAY 'ENTERDATA' GIVES THE LENGTH OF THE DATA VECTOR IN EACH ROW AS ORIGINALLY ENTERED. IF THE DATA SETS ARE OF UNEQUAL LENGTH, THE SHORTER ROWS WILL BE FILLED UP WITH ZEROS SO AS NOT TO VIOLATE ANY MATRIX STRUCTURING RULES.

A	9.1
B	9.1
C	9.1
C1	9.2
C2	9.2
C3	9.2
D	9.3
D1	9.3

LIB 9 A
LAKEHEAD UNIVERSITY, ONTARIO

THIS WS CONTAINS THE FIRST PART OF THE INTERACTIVE 'APL TEACHING COURSE' FOR PEOPLE WITH NO KNOWLEDGE OF COMPUTING.

THIS WORKSPACE CAN BE STARTED BY TYPING 'START' AND REQUIRES 45 MINUTES OF TIME.
CONTENTS: USE OF THE TERMINAL
SIMPLE CALCULATIONS
VARIABLES
ERROR MESSAGES
RIGHT TO LEFT RULE

LIB 9 B
LAKEHEAD UNIVERSITY, ONTARIO

THIS WS CONTAINS THE SECOND PART OF THE INTERACTIVE 'APL TEACHING COURSE' FOR PEOPLE WITH NO KNOWLEDGE OF COMPUTING.

THIS WORKSPACE CAN BE STARTED BY TYPING 'START' AND REQUIRES 40 MINUTES OF TIME.
CONTENTS: USE OF A STORED FUNCTION FOR SOLUTION OF A SIMPLE PROBLEM INCLUDING BRANCHING
INTRODUCTION TO WORKSPACE CONCEPT

LIB 9 C
LAKEHEAD UNIVERSITY, ONTARIO

THIS WS CONTAINS THE THIRD PART OF THE INTERACTIVE 'APL TEACHING COURSE' FOR PEOPLE WITH NO KNOWLEDGE OF COMPUTING.

THIS WORKSPACE CAN BE STARTED BY TYPING 'START' AND REQUIRES 40 MINUTES OF TIME.
CONTENTS: INTRODUCTION TO ARRAYS
A FEW PRIMITIVE FUNCTIONS
DEFINITION MODE

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LIB 9 C1
LAKEHEAD UNIVERSITY, ONTARIO

THE WORKSPACES C1, C2, C3 CONTAIN THE FOURTH PART OF
THE INTERACTIVE 'APL TEACHING COURSE' FOR PEOPLE WITH
NO KNOWLEDGE OF COMPUTING.

THIS WORKSPACE CAN BE STARTED BY TYPING 'START'.
CONTENTS: STORAGE AND MODIFICATION OF A DEFINED
          FUNCTION
          USE OF SYSTEM COMMANDS
```

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LIB 9 C2
LAKEHEAD UNIVERSITY, ONTARIO

THE WORKSPACES C1, C2, C3 CONTAIN THE FOURTH PART OF
THE INTERACTIVE 'APL TEACHING COURSE' FOR PEOPLE WITH NO
KNOWLEDGE OF COMPUTING.

THIS WORKSPACE CAN BE STARTED BY TYPING 'START'.
CONTENTS : STORAGE AND MODIFICATION OF DEFINED
           FUNCTIONS
           USE OF SYSTEM COMMANDS
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LIB 9 C3
LAKEHEAD UNIVERSITY, ONTARIO

THE WORKSPACES C1, C2, C3 CONTAIN THE FOURTH PART
OF THE INTERACTIVE 'APL TEACHING COURSE' FOR PEOPLE
WITH NO KNOWLEDGE OF COMPUTING.

THIS WORKSPACE CAN BE STARTED BY TYPING 'START'.
CONTENTS: STORAGE AND MODIFICATION OF A DEFINED
          FUNCTION
          USE OF SYSTEM COMMANDS
```

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LIB 9 D
LAKEHEAD UNIVERSITY, ONTARIO

THE WORKSPACES D, D1 CONTAIN THE FIFTH PART
OF THE INTERACTIVE 'APL TEACHING COURSE' FOR
PEOPLE WITH NO KNOWLEDGE OF COMPUTING.

THIS WORKSPACE CAN BE STARTED BY TYPING 'START'.
CONTENTS: FUNCTION MODIFICATION
          SYSTEM COMMAND
          LOCAL VARIABLES
          EXPLICIT RESULTS
          LABELS
          THE TRACE CONTROL
```

```
LIB 9 D1
LAKEHEAD UNIVERSITY, ONTARIO

THE WORKSPACES D, D1 CONTAIN THE FIFTH PART
OF THE INTERACTIVE 'APL TEACHING COURSE' FOR
PEOPLE WITH NO KNOWLEDGE OF COMPUTING.

THIS WORKSPACE CAN BE STARTED BY TYPING 'START'.
CONTENTS: FUNCTION MODIFICATION
          SYSTEM COMMAND
          LOCAL VARIABLES
          EXPLICIT RESULTS
          LABELS
          THE TRACE CONTROL
```

LIB 11 MINIPERT
IBM DISTRIBUTED

MINIPERT IS A CRITICAL PATH METHOD (CPM) SYSTEM FOR PROJECT MANAGEMENT.

THE INTENT OF MINIPERT IS TO PROVIDE AN INTERACTIVE CPM SYSTEM, WITH THE FOLLOWING FACILITIES:

-SUBNETWORKS WHOSE ACTIVITY CAPACITY IS A FUNCTION OF THE SIZE OF THE APL WORKSPACES AND LENGHT OF ACTIVITY DESCRIPTIONS.

-INTEGRATION OF SUBNETWORKS INTO A TOTAL NETWORK. THE NUMBER OF SUBNETS WITHIN A NETWORK IS A FUNCTION OF THE SUBNETWORK CAPACITY.

-MILESTONE SUMMARIZATION.

-MANPOWER LOADING

-A VARIETY OF REPORTS INCLUDING A PROJECT DIAGRAM.

THE FIVE APL WORKSPACES CONTAINED IN THE MINIPERT PACKAGE ARE:

-MINIPERT CPM NETWORK MANIPULATION AND CALCULATION
-MINIREPO BASIC CPM REPORTING FACILIRIES
-DIAGRAM GRAPHIC FOR PLOT MINIPERT PLAN
-NEWDIAGR ENHANCED DIAGRAM REPORT PROGRAM
-MANPOWER CPM RESOURCE MANIPULATION AND REPORTING.

FOR A DETAILED DESCRIPTION OF THE MINIPERT PACKAGE, SEE 'MINIPERT - PROGRAM DESCRIPTION AND OPERATIONS MANUAL - ORDER SH20-0995-0'

LIB 11 DIAGRAM
IBM DISTRIBUTED

MINIPERT IS A CRITICAL PATH METHOD (CPM) SYSTEM FOR PROJECT MANAGEMENT.
FOR MORE INFORMATION, SEE DOCUMENTATION OF 11 MINIPERT.

LIB 11 MANPOWER
IBM DISTRIBUTED

MINIPERT IS A CRITICAL PATH METHOD (CPM) SYSTEM FOR PROJECT MANAGEMENT.
FOR MORE INFORMATION, SEE DOCUMENTATION OF 11 MINIPERT.

LIB 11 MINIREPO
IBM DISTRIBUTED

MINIPERT IS A CRITICAL PATH METHOD (CPM) SYSTEM FOR PROJECT MANAGEMENT.
FOR MORE INFORMATION, SEE DOCUMENTATION OF 11 MINIPERT.

LIB 11 NEWDIAGR
IBM DISTRIBUTED

MINIPERT IS A CRITICAL PATH METHOD (CPM) SYSTEM FOR PROJECT MANAGEMENT.
FOR MORE INFORMATION, SEE DOCUMENTATION OF 11 MINIPERT.

LIB 12 STP1
K.W. SMILLIE, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS UTILITY FUNCTIONS FOR STATPACK AND FUNCTIONS FOR ANALYSIS OF VARIANCE, MEANS, VARIANCES, FREQUENCY VECTORS AND HISTOGRAMS, AND MEDIANS AND QUARTILES.

THE FOLLOWING FUNCTIONS ARE AVAILABLE IN THIS WORKSPACE:

T←ANOVA D

THIS PROGRAM DOES AN ANALYSIS OF VARIANCE ON A COMPLETE FACTORIAL DESIGN WITH ARBITRARY NUMBERS OF REPLICATIONS AND FACTORS, WITH ARBITRARY NUMBERS OF LEVELS, WITH THE RESTRICTION THAT THERE ARE NO MISSING OBSERVATIONS.
T IS A MATRIX WITH 4 COLUMNS FOR IDENTIFICATION, DEGREES OF FREEDOM, SUMS OF SQUARES, AND MEAN SQUARES. THE ROWS OF T REPRESENT REPLICATIONS, MAIN EFFECTS AND INTERACTIONS, ERROR AND TOTAL.
AS AN EXAMPLE, CONSIDER THE FOLLOWING 2×2 DESIGN WITH 3 REPLICATIONS:

```
1  2    5  6    9 10
3  4    7  8   11 12
```

WHERE THE COLUMNS WITHIN EACH SQUARE REFER TO THE FIRST FACTOR A AND THE ROWS TO THE SECOND FACTOR B. THE DATA SHOULD BE PREPARED AS A VECTOR 1,2,....,12, AND THEN RESTRUCTURED INTO D WITH DIMENSIONS (3,2,2). T WILL HAVE 6 ROWS FOR REPLICATIONS A,B AND AB EFFECTS, ERROR AND TOTAL. THE IDENTIFICATION IN THE FIRST COLUMN WILL BE 1,10 AND 11 FOR A,B AND AB, RESPECTIVELY, AND 0S FOR THE REMAINING ROWS. IF IT IS DESIRED TO TREAT THE DESIGN AS A 3×2×2 FACTORIAL WITH A SINGLE REPLICATION, THEN D MUST BE RESTRUCTURED TO HAVE DIMENSIONS (1,3,2,2). T WILL THEN HAVE 8 ROWS FOR A,B,C, AB,AC,BC, ABC AND TOTAL. THE ROWS FOR REPLICATIONS AND ERROR WILL BE OMITTED.
DATA FOR ANOVA SHOULD BE SET OUT IN THE FOLLOWING MANNER:

REPLICATIONS	TREAT B	TREAT A	ETC	DATA
R1	B1	A1		1
		A2		2
	B2	A1		3
		A2		4
R2	B1	A1		5
		A2		6
	B2	A1		7
		A2		8
R3	B1	A1		9
		A2		10
	B2	A1		11
		A2		12

THIS DATA SHOULD BE PUT IN AS A VECTOR AND THEN RESTRUCTURED AS FOLLOWS:

```
      D←1 2 3 4 5 6 ETC
      D←(R,B,A)⍴D
      ANOVA D
```

THE RESULT WILL BE AS FOLLOWS:

	IDENT	DF	SS	MS
R	0	2	128	64
A	1	1	3	3
B	10	1	12	12
AB	11	1	0	0
ERROR	0	6	0	0
TOTAL	0	11	143	0

NOTE THE DIFFERENCE BETWEEN THE RESTRUCTURING AND THE RESULT: (R,B,A) AND R,A,B. IF THERE ARE MORE DIMENSIONS THE SAME PATTERN IS FOLLOWED. (R,B,A) GOES TO B,A,R, THE RESULT BEING PRINTED AS R,A,B. (R,C,B,A) GOES TO C,B,A,R, THE RESULT BEING PRINTED AS R,A,B,C

ANOVA1

THIS FUNCTION ANALYZES A FACTORIAL DESIGN WITH NO MISSING DATA AS A CROSSED, NESTED OR CROSS-NESTED DESIGN. REPLICATIONS ARE CONSIDERED AS A FACTOR. THERE MAY BE ANY NUMBER ≥2 OF LEVELS OF ANY NUMBER ≥2 OF FACTORS.
IF THE DATA HAVE NOT BEEN STORED AS A MULTIDIMENSIONAL ARRAY (AS IN ANOVA) IN THE GLOBAL VARIABLE X, THEN ENTER A VECTOR GIVING THE NUMBER OF LEVELS OF EACH FACTOR (INCLUDING REPLICATIONS) AS THE PARAMETERS. THEN ENTER THE OBSERVATIONS, ONE AT A TIME, IN THE FORMAT: LEVEL OF 1ST FACTOR, LEVEL OF 2ND FACTOR,...., OBSERVATION. AFTER THE LAST OBSERVATION HAS BEEN ENTERED, ENTER 0.
AFTER THE GRAND MEAN AND TOTAL DF AND SS HAVE BEEN TYPED OUT, ENTER EFFECTS, ONE AT A TIME, WITH 1-FACTOR EFFECTS FIRST, 2-FACTOR EFFECTS SECOND, ETC. EFFECT 1, FOLLOWED BY EFFECT 2, FOLLOWED BY EFFECT 1 2 GIVES MAIN EFFECTS FOR FACTORS 1 AND 2 AND THEIR INTERACTION. EFFECT 1 FOLLOWED BY EFFECT 1 2 WILL GIVE MAIN EFFECT FOR FACTOR 1 AND THEN 2ND FACTOR NESTED WITHIN 1ST FACTOR. AN EFFECT OF 0 PRODUCES ANY RESIDUAL TERM.
THE DATA X AND RESIDUALS RX ARE GLOBAL VARIABLES.

```
R←ANOVA2 D
```

ANOVA2 PERFORMS AN ANALYSIS OF VARIANCE ON A ONE-WAY CLASSIFICATION WITH MISSING OBSERVATIONS. D IS AN M×N MATRIX, WHERE M IS THE NUMBER OF OBSERVATIONS FOR THE TREATMENT WITH THE MAXIMUM NUMBER OF OBSERVATIONS, AND N IS THE NUMBER OF TREATMENTS. LEGITIMATE OBSERVATIONS ARE GIVEN BY POSITIVE COMPONENTS IN D, AND MISSING OBSERVATIONS BY ZERO COMPONENTS.

R IS AN (N+3)×4 MATRIX MADE UP AS FOLLOWS:
ROW I, I=1,...,N:

I NO. OF OBSERVATIONS FOR TREATMENT I,
MEAN OF TREATMENT I, 0
ROW N+1: DF, SS, MS AND F-RATIO FOR TREATMENTS
ROW N+2: DF, SS AND MS FOR ERROR, 0
ROW N+3: DF AND SS FOR TOTAL, SQUARE ROOT OF
ERROR MS, 0.

DSTAT X

FOR A VECTOR X OF UNGROUPED OBSERVATIONS, DSTAT COMPUTES AND LISTS WITH APPROPRIATE LABELS THE FOLLOWING STATISTICS: SAMPLE SIZE, MAXIMUM OBSERVATION, MINIMUM OBSERVATION, RANGE, MEAN, VARIANCE, STANDARD DEVIATION, MEAN DEVIATION, MEDIAN AND MODE. IF THE MODE OCCURS FOR SEVERAL VALUES, EACH MODE IS LISTED, EXCEPT IF ALL OBSERVATIONS ARE DIFFERENT IN WHICH CASE NO MODE IS LISTED.

T←P FREQ X

T IS A FREQUENCY TABLE RESULTING FROM CLASSIFYING THE VECTOR X OF OBSERVATIONS ACCORDING TO THE VECTOR P, WHERE P[1] IS THE LEFT-HAND END OF THE FIRST FREQUENCY CLASS, P[2] IS THE CLASS WIDTH, P[3] IS THE NUMBER OF CLASSES, AND P[4] IS ANY NUMBER, SAY, 0. T IS A MATRIX OF P[3]+2 ROWS AND 6 COLUMNS MADE UP AS FOLLOWS:
COL 1: 0, LEFT-HAND ENDS OF FREQUENCY CLASSES, 0
COL 2: 0, RIGHT-HAND ENDS OF FREQUENCY CLASSES, 0
COL 3: 0, MID-POINTS OF FREQUENCY CLASSES, 0
COL 4: 0, OBSERVED FREQUENCIES, 0
COL 5: EXPECTED FREQUENCIES (INCLUDING TWO TAILS OF DISTRIBUTION)
COL 6: DIFFERENCES BETWEEN OBSERVED AND EXPECTED FREQUENCIES

IF THE LAST COMPONENT OF P IS OMITTED, THE NORMAL FIT IS NOT DONE, AND THE FIRST AND LAST ROWS, AND THE LAST TWO COLUMNS OF T ARE OMITTED.

F←P FR X

F IS A VECTOR OF FREQUENCIES RESULTING FROM CLASSIFYING THE VECTOR X OF OBSERVATIONS ACCORDING TO THE VECTOR P, WHERE P[1] IS THE LEFT-HAND END OF THE FIRST FREQUENCY CLASS, P[2] IS THE CLASS WIDTH, AND P[3] IS THE NUMBER OF CLASSES

T←P FR2 M

M IS A MATRIX WITH 2 ROWS GIVING THE (SAME NUMBER OF)

OBSERVATIONS ON TWO VARIABLES TO BE CLASSIFIED IN A TWO-WAY FREQUENCE TABLE. P IS A MATRIX WITH 2 ROWS AND 3 COLUMNS WHICH GIVES THE PARAMETERS FOR THE TABLE. THE COMPONENTS IN THE FIRST ROW OF P ARE AS FOLLOWS: P[1;1] IS THE LEFT-HAND END OF THE FIRST FREQUENCY CLASS, P[1;2] IS THE CLASS WIDTH, AND P[1;3] IS THE NUMBER OF CLASSES FOR THE OBSERVATIONS IN THE FIRST ROW OF M. THE COMPONENTS IN THE SECOND ROW OF P ARE SIMILARLY DEFINED FOR THE OBSERVATIONS IN THE SECOND ROW OF M. T IS A MATRIX GIVING THE FREQUENCY TABLE, WHERE THE ROWS CORRESPOND TO THE FIRST VARIABLE AND THE COLUMNS TO THE SECOND VARIABLE.

G←W HIST F

G IS A FREQUENCY HISTOGRAM GENERATED BY THE VECTOR F OF FREQUENCIES. EACH COMPONENT OF F IS DIVIDED BY THE INTEGER W>0 AND ROUNDED BEFORE PLOTTING.

T←MVSD X

X IS A MATRIX WITH THE ROWS CORRESPONDING TO OBSERVATIONS AND THE COLUMNS TO VARIATES. T IS A MATRIX WITH 3 COLUMNS, AND THE NUMBER OF ROWS EQUAL TO THE NUMBER OF COLUMNS OF X. THE FIRST COLUMN OF T GIVES THE MEANS OF THE VARIATES, THE SECOND THE VARIANCES, AND THE THIRD THE STANDARD DEVIATIONS.

T←P NTILES F

F IS A VECTOR OF FREQUENCES. P IS A 3-COMPONENT VECTOR, WHERE P[1] = LEFT-HAND END OF THE FIRST FREQUENCY CLASS, P[2] = CLASS WIDTH, AND P[3] = INTEGER>1. T IS A VECTOR. IF P[3]=2, T GIVES THE MEDIAN; IF P[3]=4, T GIVES THE 3 QUARTILES; ETC.

LIB 12 STP2
K.W. SMILLIE, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS A NUMBER OF FUNCTIONS FOR MATRIX INVERSION, SIMPLE AND PARTIAL CORRELATIONS, AND SIMPLE AND MULTIPLE LINEAR REGRESSION.

THE FOLLOWING FUNCTIONS ARE AVAILABLE:

R←CM X

R IS THE MATRIX OF SIMPLE CORRELATION COEFFICIENTS GENERATED FROM THE MATRIX X, WHERE THE ROWS OF X CORRESPOND TO OBSERVATIONS AND THE COLUMNS TO VARIATES. FOR EXAMPLE, 10 OBSERVATIONS ON EACH OF 6 VARIATES WOULD BE ASSEMBLED INTO A MATRIX WITH 10 ROWS AND 6 COLUMNS. R WOULD HAVE 6 ROWS AND 6 COLUMNS. THE ELEMENT IN ROW 3 AND COLUMN 5, SAY, OF R IS THE SIMPLE CORRELATION COEFFICIENT BETWEEN VARIATE 3 AND VARIATE 5.

C←V CORR M

M IS THE SQUARE MATRIX OF SIMPLE CORRELATION COEFFICIENTS GIVEN BY THE RESULT R OF THE FUNCTION CM. V IS A VECTOR SPECIFYING THE CORRELATION COEFFICIENT TO BE CALCULATED. SUPPOSE, E.G., M IS OF ORDER 8. THEN, IF V=(3,6), C IS THE SIMPLE CORRELATION COEFFICIENT BETWEEN VARIABLES 3 AND 6; IF V=(4,1,8,2), C IS THE PARTIAL CORRELATION COEFFICIENT BETWEEN VARIABLES 4 AND 1 WITH THE EFFECTS OF VARIABLES 8 AND 2 REMOVED; ETC.

RB←INV RA

RB IS THE INVERSE OF THE NON-SINGULAR SQUARE MATRIX RA CALCULATED BY THE GAUSS-JORDAN METHOD WITH PIVOTING FOR MATRIX INVERSION.

R←JINV M

R IS THE INVERSE OF THE NON-SINGULAR SQUARE MATRIX M CALCULATED BY THE GAUSS-JORDAN METHOD OF MATRIX INVERSION.

T←V REG X

X IS A MATRIX OF OBSERVATIONS, WHERE THE COLUMNS CORRESPOND TO VARIATES AND THE ROWS TO OBSERVATIONS. V IS A VECTOR OF POSITIVE INTEGERS. T IS A MATRIX OF 5 COLUMNS. AS AN EXAMPLE OF THE OUTPUT, LET X HAVE 6 COLUMNS, AND LET V=(3,5,1,4). THEN T GIVES THE RESULTS OF THE BEST LEAST-SQUARES FIT OF THE FUNCTION

```
  X4=A+B×X3+C×X5+D×X1
 IN THE FOLLOWING FORMAT:
  ROW1: 4, A, 0, 0, 0
  ROW2: 3, B, ST ERROR OF B, T-VALUE, 0
  ROW3: 5, C, ST ERROR OF C, T-VALUE, 0
  ROW4: 1, D, ST ERROR OF D, T-VALUE, 0
  ROW5: 0, DF FOR REGRESSION, SUM OF SQUARES, MEAN
        SQUARE, F-VALUE
  ROW6: 0, DF FOR ERROR, SUM OF SQUARES, MEAN SQUARE, 0
  ROW7: 0, DF FOR TOTAL, SUM OF SQUARES, ST ERROR OF ESTIMATE,
        SQUARE OF MULTIPLE CORR COEFF

 R←T RES X

 X IS THE MATRIX OF OBSERVATIONS DEFINED FOR REG, AND T IS
 THE RESULT OF USING REG WITH SOME VECTOR V. R IS A MATRIX,
 WITH 4 COLUMNS AND THE NUMBER OF ROWS EQUAL TO THE NUMBER
 OF ROWS IN X, WHICH GIVES THE FOLLOWING RESULTS OF FITTING
 THE REGRESSION SPECIFIED BY X AND V:
  COL 1: 1,2,...
  COL 2: OBSERVED VALUES OF DEPENDENT VARIABLE
  COL 3: ESTIMATED VALUES OF DEPENDENT VARIABLE
  COL 4: RESIDUALS

 R←SCORR D

 D IS A MATRIX OF OBSERVATIONS WITH THE ROWS CORRESPONDING TO
 OBSERVATIONS AND THE COLUMNS TO VARIATES. MISSING OBSERVATIONS
 ARE RECORDED IN D AS ANY NEGATIVE NUMBER. THE SIMPLE CORRELATION
 COEFFICIENT IS COMPUTED BETWEEN EACH DISTINCT PAIR OF VARIATES
 FOR ALL OBSERVATIONS EXCEPT THOSE IN WHICH EITHER OR BOTH
 OBSERVATIONS ARE MISSING FOR THE PARTICULAR PAIR OF VARIATES IN
 QUESTION. R IS A MATRIX WITH FOUR COLUMNS IN THE FOLLOWING
 FORMAT:
  COL 1: I=COLUMN INDEX OF FIRST VARIATE
  COL 2: J=COLUMN INDEX OF SECOND VARIATE
  COL 3: NUMBER OF OBSERVATIONS FOR VARIATES I AND J
  COL 4: CORRELATION COEFFICIENT FOR VARIATES I AND J
 IF D HAS K COLUMNS, THEN R HAS K(K-1)÷2 ROWS.

 T←X SR Y

 X AND Y ARE VECTORS GIVING THE (SAME NUMBER OF) OBSERVATIONS
 ON AN INDEPENDENT VARIABLE X AND A DEPENDENT VARIABLE Y. T IS
 A MATRIX WITH 5 ROWS AND 3 COLUMNS CONTAINING THE RESULTS OF
 FITTING THE STRAIGHT LINE Y=A+B×X BY THE METHOD OF LEAST SQUARES
 IN THE FOLLOWING FORMAT:
  ROW1: MEAN OF X, ST DEV OF X, 0
  ROW2: MEAN OF Y, ST DEV OF Y, 0
  ROW3: A, 0, 0
```

ROW4: B, ST ERROR OF B, T-VALUE
ROW5: ST ERROR OF ESTIMATE, R=SIMPLE CORR COEFF, R*2

STATRES T

T IS THE MATRIX WITH FOUR COLUMNS RESULTING FROM THE USE OF THE RESIDUAL FUNCTION RES. ITS LAST COLUMN GIVES THE RESIDUALS RESULTING FROM THE SPECIFIED REGRESSION. THIS FUNCTION GIVES THE FOLLOWING STATISTICS, COMPUTED FROM THE RESIDUALS, WITH SUITABLE LABELS: SUM OF RESIDUALS, SUM OF SQUARES OF RESIDUALS, DURBIN-WATSON STATISTICS, THE NUMBER OF RUNS OF POSITIVE AND NEGATIVE SIGNS, THE NUMBER OF POSITIVE SIGNS, THE NUMBER OF NEGATIVE SIGNS, AND THE MEAN AND STANDARD DEVIATION OF THE NUMBER OF RUNS BASED ON A NORMAL DISTRIBUTION.

T←V STREG X

THIS PROGRAM IS IDENTICAL IN FUNCTION TO THE SIMPLE AND MULTIPLE REGRESSION PROGRAM REG EXCEPT THAT THE INDEPENDENT VARIABLES ARE ENTERED INTO THE REGRESSION FUNCTION IN THE STEPWISE ORDER.
THE VECTOR V IS IDENTICAL TO THE VECTOR V IN REG EXCEPT THAT THE INDEPENDENT VARIABLES MAY BE SPECIFIED IN V IN ANY ORDER. THE FORMAT OF THE MATRIX OF RESULTS T IS IDENTICAL TO THE MATRIX T OF REG EXCEPT THAT THE PROPORTION OF THE VARIATION OF THE DEPENDENT VARIABLE ACCOUNTED FOR BY EACH INDEPENDENT VARIABLE IS GIVEN IN THE FIFTH COLUMN OF T IN THE ROWS CONTAINING THE REGRESSION COEFFICIENTS, STANDARD ERRORS AND T-VALUES FOR THE INDEPENDENT VARIABLES.

LIB 12 STP3
K.W. SMILLIE, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS FUNCTIONS FOR A VARIETY OF CALCULATIONS SUCH AS BINOMIAL AND POISSON PROBABILITIES, PERMUTATIONS, ROUNDING, SORTING AND SMOOTHING.

THE FOLLOWING FUNCTIONS ARE AVILABLE:

B←N BINOM P

CALCULATES THE VECTOR B OF PROBABILITIES IN N BINOMIAL TRIALS WITH PROBABILITY P OF SUCCESS IN A SINGLE TRIAL, WHERE N AND P ARE SCALARS, AND N IS AN INTEGER>0 AND 0≤P≤1.

R←CTAB T

CALCULATES CHI-SQUARE AND DEGREES OF FREEDOM FOR A TWO-WAY CONTINGENCY TABLE. T, A MATRIX, IS THE CONTINGENCY TABLE. R[1] IS THE DEGREES OF FREEDOM, AND R[2] IS CHI-SQUARE ROUNDED TO 2 DECIMAL PLACES.

R←PERMUTE V

V AND R ARE VECTORS GIVING TWO DIFFERENT PERMUTATIONS OF THE K≥2 INTEGERS 0,1,2,....,K-1. R IS THE PERMUTATION OBTAINED FROM V BY CONSIDERING V AS A K-DIGIT NUMBER TO BASE K, AND ADDING (K-1) BASE K SUCCESSIVELY UNTIL THE SUM CONTAINS EACH OF THE DIGITS 0,1,2,....,K-1. IF V IS THE PERMUTATION K-1,K-2,...,1,0, THEN R IS THE PERMUTATION 0,1,2,....,K-1. EXECUTION OF PERMUTE K FACTORIAL TIMES STARTING WITH V AS ANY PERMUTATION GIVES ALL K FACTORIAL PERMUTATIONS OF 0,1,2,...,K-1.

P←N POISSON K

CALCULATES THE VECTOR P OF THE FIRST N+1 PROBABILITIES FOR A POISSON DISTRIBUTION WITH PARAMETER K, WHERE N, AN INTEGER>0, AND K>0 ARE SCALARS.

R←N RND X

ROUNDS X, A SCALAR, MATRIX, ETC., TO N DECIMAL PLACES, WHERE N IS A SCALAR≥0, AND PLACES THE RESULT IN R.

V←W SMOOTH X

X IS THE VECTOR TO BE SMOOTHED BY A WEIGHTED MOVING AVERAGE USING THE VECTOR OF WEIGHTS W. V IS THE SMOOTHED VECTOR.

V←SORT X

X IS A VECTOR OF NUMBERS, WITH OR WITHOUT DUPLICATES, TO BE SORTED IN ASCENDING ORDER. V IS THE VECTOR OF SORTED NUMBERS.

LIB 12 STP4
K.W. SMILLIE, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS FUNCTIONS FOR THE SIMPLEX AND REVISED SIMPLEX ALGORITHMS, TRANSPORTATION AND CAPACITATED TRANSPORTATION PROBLEMS, ASSIGNMENT PROBLEM, VARIOUS NETWORK FLOW PROBLEMS, AND ONE PRELIMINARY CRITICAL PATH METHOD.

THE FOLLOWING FUNCTIONS ARE AVAILABLE:

ASSIGN N

THIS FUNCTION USES THE HUNGARIAN METHOD TO SOLVE AN N×N MINIMIZING ASSIGNMENT PROBLEM WITH COST MATRIX C. THE PRICES MAY BE ENTERED EITHER ROW-BY-ROW BY EXCUTING THE FUNCTION OR MAY BE PREVIOUSLY STORED IN THE N×N MATRIX C, WHERE C IS A GLOBAL VARIABLE WHICH IS UNCHANGED WHEN THE FUNCTION IS EXECUTED.
THE OUTPUT CONSISTS OF THE PROBLEM NUMBER AND DATE, THE COST OF THE OPTIMAL ASSIGNMENT, AND AN N×N LOGICAL ASSIGNMENT MATRIX IN WHICH ELEMENT (I,J) IS 1 IF AND ONLY IF ROW I IS ASSIGNED TO COLUMN J IN THE OPTIMAL ASSIGNMENT.

COSTFLOW MAX

THIS FUNCTION FINDS THE MINIMUM COST OF A GIVEN FLOW OF VALUE MAX, A SCALAR, THROUGH A NETWORK. THE NETWORK IS DEFINED BY TWO GLOBAL VARIABLES G AND C WHICH ARE N×N MATRICES, WHERE G[I;J] IS THE CAPACITY OF THE ARC FROM NODE I TO NODE J, AND C[I;J] IS THE COST OF MOVING ONE UNIT FROM NODE I TO NODE J.
THE FLOW VALUE (WHICH MAY BE LESS THAN MAX IF SUCH A FLOW IS NOT POSSIBLE) AND THE COST OF THIS FLOW ARE GIVEN IN THE GLOBAL SCALAR VARIABLES FLOW AND MINCOST, RESPECTIVELY. THE EXCESS ARC CAPACITIES ARE GIVEN BY THE MATRIX G. THE NODE NUMBERS ON THE LAST FLOW-AUGMENTING PATH ARE GIVEN BY THE VECTOR PATH. (IF G AND C ARE NOT SQUARE MATRICES OF THE SAME ORDER, THEN PATH IS SET TO AN EMPTY VECTOR AND COMPUTATION STOPS). MAXFLOW IS A GLOBAL BINARY SCALAR VARIABLE WHICH IS SET TO 1 WHEN A FLOW OF MAX IS ATTAINED.

CPT←T CPM NTW

CPM PERFORMS A CRITICAL PATH ANALYSIS ON THE NETWORK REPRESENTED BY THE MATRIX NTW USING THE NODE-ORIENTED METHOD. T IS A SCALAR WHICH IS 0 (OR 1) ACCORDING AS THE IMMEDIATE PREDECESSORS (OR SUCCESSORS) OF EACH JOB (NODE) ARE SPECIFIED.
INPUT: NTW IS A MATRIX WITH N ROWS AND M COLUMNS, WHERE N IS THE NUMBER OF NODES NUMBERED FROM 1 TO N, INCLUSIVE, IN ANY ORDER. COLUMN 1 OF NTW GIVES THE NODE NUMBERS, COLUMN 2 THE

NODE TIMES AS INTEGERS AND COLUMNS 3 TO M THE IMMEDIATE PREDECESSORS OR SUCCESSORS OF THE NODES. IF ANY NODE HAS LESS THAN M-2 IMMEDIATE PREDECESSORS OR SUCCESSORS, THE REMAINING COLUMNS IN THE CORRESPONDING ROW MUST BE FILLED OUT WITH ZEROS.

OUTPUT: FOR EACH ANALYSIS THE FOLLOWING OUTPUT IS GIVEN AS A MATRIX WITH ONE ROW FOR EACH NODE: NODE NUMBER IN SUCCESSOR ORDER (THAT IS NODE I IS GIVEN BEFORE THE NODES WHICH ARE ITS IMMEDIATE SUCCESSORS), NODE TIME, EARLIEST START TIME, TOTAL SLACK AND FREE SLACK. EACH ROW ON THE CRITICAL PATH, THAT IS NODES WITH A TOTAL SLACK OF ZERO, IS PRECEDED BY AN ASTERISK. THE OUTPUT IS ALSO STORED, APART FROM THE ASTERISKS, IN THE MATRIX CPT.

SECONDARY OUTPUT: THE NETWORK NTW, SORTED IN THE SAME NODE ORDER AS CPT, IS STORED IN THE MATRIX CPΔ. THE LOGICAL MATRIX PSM WITH N ROWS AND COLUMNS GIVES THE PREDECESSOR-SUCCESSOR RELATIONSHIPS BETWEEN NODES. ROW I GIVES THE SUCCESSORS OF THE I-TH NODE OF CPΔ AND COLUMN I GIVES THE PREDECESSORS, WHERE AN ENTRY OF 1 INDICATES A PREDECESSOR-SUCCESSOR RELATIONSHIP.

ERROR-EXITS: IF THE N NODES ARE NOT NUMBERED, IN SOME ORDER, FROM I TO N INCLUSIVE, NODE NUMBERING ERROR FOLLOWED BY A VECTOR OF SORTED NODE NUMBERS IS GIVEN, AND COMPUTATION IS ENDED. IF THERE ARE ANY LOOPS OR DISCONTINUITIES IN THE NETWORK LOOP/DISCONTINUITY AT NODE FOLLOWED BY THE NODE NUMBERS AT OR PRECEDING WHICH AN ERROR OCCURRED IS GIVEN, AND COMPUTATION IS ENDED.

REFERENCE: LEVY, THOMPSON AND WEST, HARVARD BUSINESS REVIEW, VOL.41, NO.5, PP.98-108, SEPT.-OCT., 1963.

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S←CAP CTRANSPORT COST
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THIS FUNCTION USES THE PRIMAL-DUAL ALGORITHM TO SOLVE THE CAPACITATED TRANSPORTATION PROBLEM. COST IS AN (M+1)×(N+1) MATRIX, WHERE COST[I;J] IS THE UNIT COST OF SHIPPING FROM ORIGIN I TO DESTINATION J, WHERE I=1,...,M AND J=1,...,N. COST[I;N+1] IS THE AMOUNT AVAILABLE AT ORIGIN I=1,...,M AND COST[M+1;J] IS THE AMOUNT REQUIRED AT DESTINATION J=1,...,N. THE SUM OF THE ORIGIN AVAILABILITIES MUST BE EQUAL TO THE SUM OF THE DESTINATION REQUIREMENTS. CAP IS AN M×N MATRIX, WHERE CAP[I;J] IS THE CAPACITY RESTRICTION ON THE ROUTE FROM ORIGIN I TO DESTINATION J.

S IS AN M×N MATRIX WITH S[I;J] GIVING THE NUMBER OF UNITS SHIPPED FROM ORIGIN I TO DESTINATION J IN THE OPTIMAL SOLUTION. THE CORRESPONDING MINIMUM COST IS GIVEN IN THE GLOBAL SCALAR VARIABLE MINCOST. IF THERE IS NO FEASIBLE SOLUTION, A SUITABLE MESSAGE IS GIVEN IN S WHICH IS THEN A MATRIX WITH ONE ROW, AND MINCOST IS THE EMPTY VECTOR.

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B LPSOLN A
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THIS FUNCTION RECALCULATES THE OPTIMAL SOLUTION AND DOES A SENSITIVITY ANALYSIS FOR THE PRICE AND REQUIREMENT VECTORS FOR A LINEAR PROGRAMMING PROBLEM.
THE MATRIX A IS THE SAME MATRIX A AS REQUIRED FOR EITHER SIMPLEX OR RSIM, AND THE VECTOR B GIVES THE VARIABLES IN THE OPTIMAL BASIS. LPSOLN SHOULD NOT BE USED IF SOME COLUMNS OF A CORRESPOND TO ARTIFICAL VARIABLES.
THE OUTPUT CONSISTS OF THE FOLLOWING INFORMATION WITH IDENTIFYING LABELS:
MAXIMUM VALUE OF OBJECTIVE FUNCTION.
VARIABLES IN OPTIMAL BASIS AND THEIR VALUES.
MARGINAL VALUE, LOWER BOUND, RIGHT-HAND SIDE AND UPPER BOUND FOR THE RIGHT-HAND SIDE OF EACH CONSTRAINT.
LOWER BOUND, PRICE AND UPPER BOUND FOR EACH NON-ZERO PRICE.
INFINATE LOWER AND UPPER BOUNDS ARE INDICATED BY VALUES OF -7.237E75 AND 7.237E75, RESPECTIVELY.

NETFLOW

THIS FUNCTION USES THE FORD-FULKERSON ALGORITHM TO CALCULATE THE MAXIMUM FLOW IN A CAPACITATED NETWORK. THE INPUT CONSISTS OF TWO GLOBAL VARIABLES G AND N, WHERE G IS AN N×N CAPACITY MATRIX SUCH THAT G[I;J] IS THE CAPACITY OF THE DIRECTED ARC FROM NODE I TO NODE J, AND N IS A SCALAR. THE FUNCTION LEAVES THE MAXIMUM FLOW IN THE GLOBAL SCALAR VARIABLE FLOW AND THE EXCESS ARC CAPACITIES IN THE MATRIX G. IT ALSO GENERATES AN N-COMPONENT GLOBAL VECTOR DELTA.
REFERENCE: HADLEY, G., 1962. LINEAR PROGRAMMING. (ADDISON-WESLEY).

T←RSIM A

THIS FUNCTION USES THE REVISED SIMPLEX ALGORITHM TO SOLVE THE LINEAR PROGRAMMING PROBLEM SPECIFIED BY THE MATRIX A. THE FIRST ROW OF A, EXCEPT FOR THE LAST COLUMN WHICH IS ALWAYS ZERO, GIVES THE PRICES. THE REMAINING ROWS GIVE THE CONSTRAINTS WITH NECESSARY SLACK AND SURPLUS VARIABLES, AND THE REQUIREMENTS VECTOR WITH NON-NEGATIVE COMPONENTS IN THE LAST COLUMN. NOTE THAT ARTIFICIAL VARIABLES ARE NOT REQUIRED.
T IS A MATRIX WITH 2 COLUMNS. THE FIRST COLUMN GIVES THE VARIABLES IN THE OPTIMAL BASIS EXCEPT FOR THE LAST ROW WHICH IS ALWAYS ZERO. THE SECOND COLUMN GIVES THE VARIABLES IN THE OPTIMAL BASIS EXCEPT FOR THE LAST ROW WHICH GIVES THE OPTIMAL VALUE OF THE OBJECTIVE FUNCTION. IF THE PROBLEM HAS EITHER AN UNBOUNDED SOLUTION OR A NON-FEASIBLE SOLUTION, THEN THE PROPER INDICATION IS GIVEN IN T WHICH IS THEN AN ALPHANUMERIC MATRIX WITH A SINGLE ROW.

EACH LINEAR PROGRAMMING PROBLEM SOLVED WITH THIS FUNCTION MUST BE A MAXIMIZING PROBLEM.

RSIM1

THIS FUNCTION ASSEMBLES THE INPUT FOR THE FUNCTION RSIM, TRANSFERS CONTROL TO RSIM AND GIVES THE OUTPUT WITH SUITABLE LABELS. THE DOCUMENTATION FOR RSIM SHOULD BE CONSULTED FOR THE FORM IN WHICH THE OBJECTIVE FUNCTION AND CONSTRAINTS SHOULD BE PUT.

R←B SIMPLEX A

THIS FUNCTION USES THE SIMPLEX ALGORITHM TO SOLVE THE LINEAR PROGRAMMING PROBLEM SPECIFIED BY THE MATRIX A. THE ROWS OF A GIVE THE CONSTRAINTS WITH NECESSARY SLACK AND SURPLUS VARIABLES, AND ALSO ARTIFICIAL VARIABLES WHERE NECESSARY TO MAKE UP AN IDENTITY MATRIX. THE LAST COLUMN OF A, EXCEPT FOR THE FIRST ELEMENT WHICH IS ALWAYS ZERO, GIVES THE REQUIREMENTS VECTOR. THE FIRST ROW OF A, EXCEPT FOR THE LAST ELEMENT, GIVES THE PRICES. B IS A VECTOR OF POSITIVE INTEGERS WHICH GIVES THE COLUMN NUMBERS CORRESPONDING TO THE IDENTITY MATRIX.
R IS A MATRIX WITH 2 COLUMNS. THE FIRST COLUMN GIVES THE VARIABLES IN THE OPTIMAL BASIS EXCEPT FOR THE LAST ROW WHICH IS ALWAYS ZERO. THE SECOND COLUMN GIVES THE VARIABLES IN THE OPTIMAL BASIS EXCEPT FOR THE LAST ROW WHICH GIVES THE OPTIMAL VALUE OF THE OBJECTIVE FUNCTION. IF THE PROBLEM HAS AN UNBOUNDED SOLUTION, THEN THE PROPER INDICATION IS GIVEN IN R WHICH IS THEN AN ALPHANUMERIC VECTOR.
EACH LINEAR PROGRAMMING PROBLEM SOLVED WITH THIS FUNCTION MUST BE A MAXIMIZING PROBLEM.

S←TRANSPORT COST

THIS FUNCTION USES THE PRIMAL-DUAL ALGORITHM TO SOLVE THE TRANSPORTATION PROBLEM. COST IS AN $(M+1)\times(N+1)$ MATRIX, WHERE COST[I;J] IS THE UNIT COST OF SHIPPING FROM ORIGIN I TO DESTINATION J, WHERE $I=1,\ldots,M$ AND $J=1,\ldots,N$. COST[I;N+1] IS THE AMOUNT AVAILABLE AT ORIGIN I, $I=1,\ldots,M$, AND COST[M+1;J] IS THE AMOUNT REQUIRED AT DESTINATION J, $J=1,\ldots,N$. COST[M+1;N+1] IS ARBITRARY. THE SUM OF THE ORIGIN AVAILABILITIES MUST BE EQUAL TO THE SUM OF THE DESTINATION REQUIREMENTS.
S IS AN $M\times N$ MATRIX WITH S[I;J] GIVING THE NUMBER OF UNITS SHIPPED FROM ORIGIN I TO DESTINATION J IN THE OPTIMAL SOLUTION. THE CORRESPONDING MINIMUM COST IS GIVEN IN THE GLOBAL SCALAR VARIABLE MINCOST.

LIB 12 STP5
K.W.SMILLIE, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS A SET OF FUNCTIONS
FOR PERFORMING A CRITICAL PATH ANALYSIS FOR AN
ACTIVITY-ORIENTED NETWORK.

TO USE THIS WORKSPACE TYPE THE COMMAND CPM1. THE INPUT CONSISTS OF THE NODE NUMBER, NODE DURATION AND SUCCESSOR NODE NUMBERS FOR EACH NODE. IF THERE ARE N NODES, THEY SHOULD BE NUMBERED IN ANY ORDER FROM 1 TO N. FOR CONVENIENCE OF OUTPUT THE DURATIONS SHOULD BE INTEGERS. THE OUTPUT CONSISTS OF THE FOLLOWING INFORMATION WITH SUITABLE LABELS: PROBLEM NUMBER AND DATE, LENGTH OF CRITICAL PATH, CRITICAL ACTIVITIES, NODE NUMBERS, DURATIONS, EARLY START AND FINISH TIMES, LATE START AND FINISH TIMES, TOTAL AND FREE SLACKS. ERROR INDICATIONS ARE GIVEN FOR INCORRECT NODE NUMBERING, MULTIPLE INITIAL AND TERMINAL NODES, AND NETWORK LOOPS, AND COMPUTATION IS THEN STOPPED.
IF THE INPUT DATA ARE TO BE TYPED IN, ANSWER YES TO THE QUESTION 'IS THIS A NEW PROBLEM?', AND FOLLOW THE INSTRUCTIONS THAT ARE TYPED OUT. THE INITIAL DATA ARE STORED, ONE ROW FOR EACH NODE, IN THE GLOBAL VARIABLE DATA SO THAT CORRECTIONS MAY BE MADE TO THE DATA WITHOUT ENTERING ALL THE DATA AGAIN. TO RESTART AFTER MAKING CORRECTIONS TO DATA, ANSWER NO TO THE QUESTION 'IS THIS A NEW PROBLEM?'.

LIB 12 STP6
K.W. SMILLIE, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS A SET OF FUNCTIONS
FOR A CONVERSATIONAL LINEAR PROGRAMMING PROGRAM.

THE FOLLOWING FUNCTION IS AVAILABLE:

LINPR

THIS FUNCTION ALLOWS A LINEAR PROGRAMMING PROBLEM TO BE ENTERED IN AN ALGEBRAIC LANGUAGE SIMILAR TO THAT IN WHICH THE PROBLEM IS NORMALLY STATED. TO LEARN HOW TO USE THE FUNCTION TYPE

LINPR

AND ANSWER ALL QUESTIONS WITH YES OR NO.
THE GLOBAL VARIABLES C, DATA, M, AND SLACK ARE GENERATED BY EXECUTION OF LINPR.

LIB 12 STP7
K.W. SMILLIE, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS A SET OF FUNCTIONS INTENDED FOR THE ANALYSIS OF ORTHOGONAL FACTORIAL EXPERIMENTS. COMPLETE DOCUMENTATION IS GIVEN IN DEPARTMENT OF COMPUTING SCIENCE PUBLICATION NO. 18 BY K.W. SMILLIE WHICH IS AVAILABLE AT THE UNIVERSITY OF ALBERTA BOOKSTORE.

THE FUNCTIONS IN THIS WORKSPACE ARE INTENDED FOR THE ANALYSIS OF ORTHOGONAL FACTORIAL EXPERIMENTS WITH UP TO SIX FACTORS, ONE OF WHICH MAY REPRESENT REPLICATIONS, AND AN ARBITRARY NUMBER OF LEVELS OF EACH FACTOR. THE ANALYSIS-OF-VARIANCE TABLE GIVES THE DEGREES OF FREEDOM, SUM OF SQUARES AND MEAN SQUARE FOR EACH MAIN EFFECT AND INTERACTION TERM. SPECIFIED TERMS MAY BE POOLED TO ACCOMMODATE DESIGNS WHICH ARE NOT COMPLETE FACTORIALS, SUCH AS SPLIT-PLOT DESIGNS. ORTHOGONAL SINGLE-DEGREE-OF-FREEDOM CONTRASTS MAY BE CALCULATED FOR ANY MAIN EFFECT OR INTERACTION TERM. FINALLY, A METHOD IS PROVIDED FOR OBTAINING THE ANALYSIS-OF-VARIANCE TABLE FOR ANY CROSSED, NESTED OR PARTIALLY-NESTED DESIGN FROM AN ALGEBRAIC SPECIFICATION OF THE APPROPRIATE LINEAR MODEL.
A COMPLETE ACCOUNT OF THE FUNCTIONS TOGETHER WITH EXAMPLES OF THEIR USE IS GIVEN IN SOME APL ALGORITHMS FOR ORTHOGONAL FACTORIAL EXPERIMENTS BY K.W. SMILLIE, DEPARTMENT OF COMPUTING SCIENCE PUBLICATION NO. 18.

LIB 12 STP8
K.W. SMILLIE, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS A SET OF FUNCTIONS TO BE USED IN A CONVERSATIONAL MANNER FOR MULTIPLE LINEAR REGRESSION CALCULATIONS.

THIS FUNCTIONS ARE SIMILAR TO THOSE ALREADY AVAILABLE IN STATPACK BUT WITH SIMPLIFIED INPUT AND ANNOTATED OUTPUT. THE FOLLOWING OPERATIONS ARE PROVIDED:

1) INPUT OF INITIAL DATA
2) OUTPUT OF INITIAL DATA
3) MEANS, VARIANCES AND STANDARD DEVIATIONS
4) SIMPLE CORRELATIONS
5) PARTIAL CORRELATIONS
6) MULTIPLE REGRESSION, WITH STEPWISE OPTION
7) RESIDUALS
8) TESTS ON RESIDUALS.

TO USE MREG, LOAD WORKSPACE STP8 AND TYPE MREG . ANSWER QUESTIONS WITH YES OR NO . AN ANSWER OF NO TO CONTINUE? WHICH OCCURS AFTER 2) AND 5), AND TO MORE REGRESSIONS WITH THESE DATA? WHICH OCCURS AFTER 8) CAUSES AN EXIT FROM MREG. THE INITIAL DATA ARE STORED IN THE GLOBAL VARIABLE DATA WHICH IS A MATRIX WITH ROWS CORREPONDING TO OBSERVATIONS AND COLUMNS TO VARIATES.

LIB 13 STAT1
R. LIKNAITZKY;D.E.R.S;U. OF A.

THIS WORKSPACE CONTAINS FUNCTIOS FOR VARIOUS STATISTICAL APPLICATIONS.

IMPLEMENTED TO DATE ARE:

ANOVA10	ONE-WAY ANALYSIS OF VARIANCE
ASIGN	SIGN TEST
ATAN4	ARCTANGENT REQUIRED FOR VARIMAX FUNCTION
CHIPR	PROBABILITY OF CHI-SQUARE
CORREL	MEANS,STANDARD DEVIATIONS,AND CORRELATIONS
DIAG	DIAGONAL FACTORING OF A MATRIX
ERRORF	NORMAL CURVE
FACTOR	HOTELLING PRINCIPAL AXIS FACTORING
FPR	PROBABILITY OF F
KOLR	KOLMOGOROV-SMIRNOV TEST
KWA	KRUSKAL-WALLIS ANALYSIS OF VARIANCE
PLEVEL	PROBABILITY OF F
RANK	RANK VALUES
RND	ROUND
VARIMAX	VARIMAX ORTHOGONAL ROTATION
WILMSR	WILCOXIN MATCHED PAIR SIGNED RANK TEST

FUNCTION	SYNTAX	AUTHOR
ANOVA10	ANOVA10 T	K BAY ED948 PH3764 1/5/68

STANDARD ONE WAY ANALYSIS OF VARIANCE. ACCEPTS UNEQUAL N. USE 0 FOR MISSING MEASUREMENT TO COMPLETE INPUT DATA MATRIX. IF ACTUALLY OBSERVED VALUE IS 0, USE VERY SMALL NUMBER SUCH AS 1E¯20 FOR THE VALUE. COMPUTER ASSUMES 0 AS MISSING MEASUREMENT. TO TEST THE HYPOTHESIS THAT VARISNCES ARE HOMOGENEOUS USING BARTLETT APPROX METHOD, CHISQ AND PROB ARE CALCULATED. IF P<0.05 WARNING MESSAGE IS GIVEN.
T IS A DATA MATRIX WHERE ROW REPRESENTS REPEATED MEASUREMENT PER PERSON OR SAMPLE. REQUIRES CHIPR AND ERRORF. FOR REFERENCE SEE KEEPING INTRODUCTION TO STATISTICAL INFERENCE P215.

ASIGN	PROB←X ASIGN Y	S HUNKA

WHERE X AND Y ARE DATA VECTORS. ASIGN RETURNS THE NUMBER OF DIFFERENCES GREATER THAN ZERO OR THE NUMBER LESS THAN ZERO WHICH EVER IS SMALLER, THE NUMBER OF NON-ZERO DIFFERENCES, AND THE PROBABILITY.

ATAN4	SC←N ATAN4 D	S HUNKA

THIS FUNCTION CALCULATES THE COS AND SIN FOR TAN 4 THETA GIVEN THE NUMERATOR N AND DENOMINATOR D FOR THE TANGENT. THE VECTOR SC CONTAINS THE FOLLOWING: SC[1] IS 1 IF THE ANGLE OF ROTATION IS SUFFICIENTLY LARGE TO WARRENT A ROTATION OF THE CURRENTLY AVAILABLE FAC-

TORS, OTHERWISE IT IS 0, SC[2] IS COS THETA, SC[3] IS SIN THETA. IF SC[1] IS 0, SC[2] AND SC[3] WILL ALSO BE 0. THE FUNCTION ALSO REQUIRES THE PARAMETER TOL WHICH FOR THE VARIMAX ROTATION MAY BE SET AT 0.05.

CHIPR P←F CHIPR X K BAY
CALCULATES PROBABILITY P(X≤CHISQ) WHEN DEGREES OF FREEDOM AND X IS GIVEN. F IS DEGREES OF FREEDOM, X IS OBSERVED CHISQ, P IS THE PROBABILITY OF OBSERVING A SAMPLE VALUE OF CHISQ GREATER THAN OR EQUAL TO X UNDER THE HYPOTHESIS. THIS PROGRAM IS BASED ON ALGORITHM 299, CHISQ INTEGRAL BY HILL AND PIKE. SEE COMM OF COMPUTING MACHINERY 10,4 P243 APRIL 1967. REQUIRES ERRORF. IF F<1 OR X≤0 ERROR MESSAGE IS GIVEN.

CORREL R←CORREL S S HUNKA
THIS FUNCTION CALCULATES MEANS STANDARD DEVIATIONS AND CORRELATION COEFFICIENTS FOR A SCORE MATRIX OF ORDER NP BY N, WHERE NP IS THE NUMBER OF OBSERVATIONS AND N THE NUMBER OF VARIABLES. IN THE SYNTAX S IS THE MATRIX OF SCORES AND R IS THE CORRELATION MATRIX. THE MEANS AND THE STANDARD DEVIATIONS ARE NOT RETURNED BUT ARE AVAILABLE IN THE VECTOR MS[1;] AND MS[2;] RESPECTIVELY.

DIAG A←N DIAG R S HUNKA
THIS FUNCTION PERFORMS A DIAGONAL FACTORING OF A MATRIX. N IS THE NUMBER OF FACTORS TO EXTRACT AND R THE MATRIX OF CORRELATION COEFFICIENTS. THE FUNCTION SELECTS THE COLUMN CONTAINING THE LARGEST DIAGONAL ELEMENT AS THE BASIS FOR EXTRACTING THE NEXT FACTOR. THIS FUNCTION REQUIRES THE FUNCTION RND FOR ROUNDING OFF.

ERRORF P←ERRORF Z K BAY
CALCULATES NORMAL INTEGRAL P(0<X<|Z|) WHERE X IS STANDARD NORMAL VARIATE AND Z IS UPPER LIMIT OF INTEGRAL. P IS THE PROBABILITY I.E. THE AREA UNDER NORMAL CURVE LIKE USUAL NORMAL TABLE. SEE HASTING APPROXIMATIONS FOR DIGITAL COMPUTERS PP187.

FACTOR A←NF FACTOR RA S HUNKA
NF IS A SCALAR CONTAINING THE NUMBER OF FACTORS TO EXTRACT, A IS THE MATRIX TO BE FACTORED. EIGENVALUES AND EIGENVECTORS ARE ALSO GIVEN.

FPR P←DF FPR F K BAY
CALCULATES APPROXIMATE PROB VALUE OF F DISTRIBUTION. DF IS A VECTOR OF TWO COMPONENTS: DF[1] IS DF OF NUMERATOR MS, DF[2] IS DF OF DENOMINATOR MS. F IS CALCULATED F RATIO, P IS PROBABILITY. THIS PROGRAM IS A NORMAL APPROXIMATION AND GIVES TWO DECIMAL PLACES. IF DF<3 OR PRECISE VALUE IS WANTED, FUNCTION PLEVEL IS RECOMMENDED. REF: KENDAL ADVANCED THEORY OF STATISTICS P382.

KOLR MAXD←KOLR D S HUNKA
GIVEN A VECTOR OF DATA IN D MAXD IS RETURNED INDICATING THE MAXI-

MUM DIFFERENCE BETWEEN THE OBSERVED ARRAY AND A THEORETICAL ARRAY DETERMINED ON THE BASIS OF EQUAL PROBABILITY.

KWA H←NG KWA X S HUNKA
NG IS A VECTOR CONTAINING THE NUMBER OF OBSERVATIONS IN EACH GROUP, X IS A VECTOR CONTAINING THE OBSERVED DATA AND ORDERED IN THE SAME ORDER AS THE SAMPLE SIZES IN NG. THE ARGUEMENT H IS RETURNED.

PLEVEL P←DF PLEVEL F K RAY
THIS IS BASED ON FORTRAN SUBROUTINE PLEVEL. GIVEN DEGREES OF FREEDOM FOR BOTH NUMERATOR (DF[1]) AND DENOMINATOR (DF[2]), AND F RATIO, THE FUNCTION CALCULATES THE PROB OF THE OBSERVED F OR LARGER OCCURING. REQUIRES PROBLY, BTALOG, GAMLOG, BASHLIN, SIN, AND ARCSIN. THIS PROGRAM IS RATHER TIME CONSUMING. THEREFORE IF DF≥3 AND PRECISE VALUE OF P IS NOT REQUIRED FASTER APPROXIMATION FPR IS RECOMMENDED. THE FUNCTION FPR IS ACCURATE TO TWO DECIMAL PLACES IF DF≥3.

RANK R←RANK X S HUNKA
GIVEN A VECTOR X, R IS RETURNED CONTAINING THE RANK ORDER VALUES.

RND R←N RND X W S ADAMS
X MAY BE A VECTOR OR A SCALAR WHICH IS TO BE ROUNDED, WHILE N IS THE NUMBER OF FIGURES WHICH THE ROUNDED VALUE SHOULD HAVE.

VARIMAX VARIMAX A S HUNKA
THIS FUNCTION PERFORMS AN ORTHOGONAL ROTATION. A IS THE FACTOR MATRIX TO BE ROTATED. THIS FUNCTION CALLS THE FUNCTIONS ATAN4,RND.

WILMSR T←X WILMSR Y S HUNKA
X AND Y ARE VECTORS OF OBSERVED DATA. THE SUM OF THE POSITIVE AND NEGATIVE DIFFERENCES IS RETURNED.

LIB 13 STAT2

THIS WS CONTAINS SAME MISCELLANEOUS STATISTICAL FUNCTIONS.

THE FOLLOWING FUNCTIONS CAN BE USED:

MEANS X

X, THE INPUT TO THIS PROGRAM, IS AN ARRAY (≤8 DIMENSIONS) CONTAINING YOUR RAW DATA, WITH ¯999999 FILLED IN FOR MISSING OBSERVATIONS. THE PROGRAM WILL ASK FOR THE SETS OF MEANS YOU WANT DISPLAYED, ONE SET AT A TIME. IF YOU WANT THE MEANS ACROSS THE FIRST DIMENSION (FACTOR), TYPE 1 IN RESPONSE; ACROSS THE SECOND DIMENSION, TYPE 2; ACROSS THE THIRD DIMENSION, TYPE 3; ACROSS THE FIRST AND THIRD DIMENSIONS, TYPE 13; ACROSS THE SECOND AND FOURTH DIMENSIONS, TYPE 24; ACROSS THE FIRST, THIRD AND FOURTH DIMENSIONS, TYPE 134;ETC. IF YOU WANT THE OVERALL MEAN, TYPE 9. WHEN YOU HAVE ALL THE MEANS YOU WANT, ENTER A 0 TO GET OUT OF THE FUNCTION.

T←N ARCSIN X

THIS PROGRAM DOES THE ARCSIN TRANSFORMATION AS PROPOSED BY N.F. LAUBSCHER, ON STABILIZING THE BINOMIAL AND NEGATIVE BINOMIAL VARIANCES, AMERICAN STATISTICAL ASSOCIATION JOURNAL, VOL. 56, 1961, PP.143-150.

TO USE THIS TRANSFORMATION, YOUR RAW DATA MUST BE DRAWN FROM A POPULATION WHICH FOLLOWS A BINOMIAL DISTRIBUTION. (I.E. YOUR DATA WILL BE OF THE FORM OF A NUMBER OF CORRECT (OR INCORRECT) RESPONSES IN 'N' TRIALS.) N IS A SCALAR WHICH IS THE MAXIMUM NUMBER OF CORRECT RESPONSES. X IS ANY TYPE OR SIZE OF ARRAY CONTAINING RAW DATA, WHERE EACH ELEMENT IN X IS A NUMBER OF CORRECT RESPONSES. T IS AN ARRAY OF EXACTLY THE SAME TYPE AND SIZE AS X, EACH ELEMENT IN T BEING THE TRANSFORMED VALUE FOR THE CORRESPONDING ELEMENT IN X.

LIB 14 DFREE
J.A. REDFIELD; DEPT OF ZOOLOGY; UNIV. OF ALBERTA

THE WORKSPACE 'DFREE' CONTAINS STATISTICAL TESTS TO BE USED IN CONJUNCTION WITH NON-PARAMETRIC OR DISTRIBUTION-FREE DATA.

THE FOLLOWING FUNCTIONS ARE AVILABLE:

O CHI E

CHI CALCULATES GOODNESS-OF-FIT CHI SQUARE FROM THE OBSERVED VALUES O AND THE EXPECTED VALUES E. BOTH O AND E ARE VECTORS OF THE SAME SIZE.
THE FORMULA USED IS:

$$/\!\backslash^{2} = \sum \frac{(O-E)^{2}}{E}$$

T RC TT

RC COMPUTES A STATISTIC 'G' FOR A ROWS BY COLUMNS CONTINGENCY TABLE OF ANY SIZE. 'G' IS THE SAME AS CHI-SQUARE AND THIS TEST IS IDENTICAL TO A ROWS BY COLUMNS CONTINGENCY CHI-SQUARE.
T IS A TWO COMPONENT VECTOR OF THE SIZE OF THE CONTINGENCY TABLE (ROWS=FIRST COMPONENT; COLUMNS=SECOND COMPONENT) AND TT IS A VECTOR OF OBSERVATIONS IN THE CONTINGENCY TABLE, ENTERED ROW BY ROW.
TO USE THIS FUNCTION, ENTER THE SIZE OF THE TABLE FOLLOWED BY RC FOLLOWED BY THE RAVELED TABLE. SEE SOKAL AND ROHLF (1969), PAGES 598-601 FOR FURTHER DETAILS OF THIS TEST.

P BT N

BT COMPUTES T FOR TWO BINOMIAL PROPORTIONS, P AND THEIR CORRESPONDING SAMPLE SIZES, N. THE FORMULA USED IS:

$$T=\frac{ARCSIN(P_1^{0.5})-ARCSIN(P_2^{0.5})}{\left(820.8\left(\frac{1}{N_1}+\frac{1}{N_2}\right)\right)^{0.5}}$$

WHERE
P1 =LARGEST PROPORTION
P2 =SMALLEST PROPORTION
N1 =SAMPLE SIZE OF FIRST PROPORTION
N2 =SAMPLE SIZE OF SECOND PROPOPTION

IF SAMPLE SIZES ARE SMALL THIS TEST IS NOT AS EFFICIENT AS OTHERS, SUCH AS FISHER'S EXACT TEST. SEE SOKAL AND ROLFF (1969) PAGES 607-608 FOR FULL DETAILS OF THIS TEST.

TBYT X

TBYT COMPUTES CONTINGENCY CHI-SQUARE (WITH YATE'S CORRECTION) FOR ANY 2 × 2 TABLE. THE FUNCTION RETURNS CHI-SQUARE WITH 1 DF. IF SOME OR ALL OF THE CELL NUMBERS ARE <10, FISHERS MAY BE A MORE APPROPRIATE ROUTINE.

V SIZE Q

SIZE COMPUTES THE SAMPLE SIZE TO BE X o/o CERTAIN OF DETECTING A TRUE DIFFERENCE BETWEEN TWO PROPORTIONS, REPRESENTED BY Q, AT THE Y LEVEL OF SIGNIFICANCE.
V IS A TWO COMPONENT VECTOR OF Y AND X. Y AND X MUST HAVE THE FOLLOWING VALUES:
Y MUST BE 0.1 OR 0.05 OR 0.01 OR 0.001;
X MUST BE 50 OR 80 OR 90 OR 99 (THESE ARE PERCENTAGES).
TO USE THE FUNCTION, ENTER Y FOLLOWED BY X THEN THE WORD SIZE FOLLOWED BY THE TWO PROPORTIONS. SOKAL AND ROHLF (1969) PAGES 608-610 GIVE THE DETAILS OF THIS CALCULATION.

E HET O

HET COMPUTES THE STATISTIC 'G' (=CHI-SQUARE) FOR A SERIES OF REPLICATED GOODNESS-OF-FIT TESTS. OUTPUT GIVES 'G' FOR THE POOLED DATA, FOR HETEROGENEITY BETWEEN TESTS, FOR EACH INDIVIDUAL TEST, AND FOR THE TOTAL, ALL IN SUITABLE FORMAT.
E IS THE EXPECTED RATIO (A VECTOR IN INTEGER FORM) IN THE REPLICATED TESTS AND O IS A TABLE WITH EACH ROW REPRESENTING ONE TEST.
TO USE THE FUNCTION, ENTER THE EXPECTED RATIO (IN INTEGER FORM) FOLLOWED BY HET FOLLOWED BY THE TABLE OF OBSERVATIONS. SEE SOKAL AND ROHLF (1969) PAGES 575-579 FOR FURTHER DETAILS OF THIS TEST.

A FISHERS B

FISHERS COMPUTES THE EXACT PROBABILITY OF OBTAINING THE OBSERVED RESULTS AND ALL WORSE CASES IN A 2×2 CONTINGENCY TABLE.

THIS TEST IS KNOWN AS FISHER'S EXACT TEST AND ANSWERS THE FOLLOWING QUESTION: GIVEN TWO-WAY TABLES WITH THE SAME FIXED MARGINAL TOTALS AS THE OBSERVED ONE, WHAT IS THE CHANCE OF OBTAINING THE OBSERVED CELL FREQUENCIES AND ALL CELL FREQUENCIES REPRESENTING A GREATER DEVIATION FROM EXPECTATION? SOKAL AND ROHLF (1969) GIVE THE DETAILS OF THIS COMPUTATION (PP.593-598). A IS ONE ROW OF A TWO BY TWO CONTINGENCY TABLE AND B IS THE OTHER ROW. THE ANSWER IS AN EXACT PROBABILITY. THIS FUNCTION REQUIRES THE VARIABLE LOGFACTORIALS WHICH IS THE LOGARITHMS OF 0-499 FACTORIAL,(LOG OF 0!,...499! AND IS IN THIS WORKSPACE. ONE CAN USE FISHERS FOR ANY 2×2 CONTINGENCY TABLE (AS LONG AS N (TOTAL) IS LESS THEN 499) BUT IT IS NO BETTER THAN TBYT (G-TEST WITH YATES' CORRECTION) WHEN ALL CELL FREQUENCES ARE >10.

H←KRUSKAL X

KRUSKAL IS A FUNCTION FOR THE KRUSKAL-WALLIS TEST. THIS IS A TEST FOR DIFFERENCES OF LOCATION OF MEDIAN IN DATA GROUPED BY A SINGLE CLASSIFICATION. IT IS EQUIVALENT TO ANOVA WITH A SINGLE CLASSIFICATION.

X IS A R×A TABLE WITH THE COLUMNS BEING TREATMENTS AND THE ROWS REPLICATES. FOR MISSING DATA, ENTER 0. FOR ACTUAL 0, ENTER A VERY SMALL NUMBER. SAMPLE SIZES NEED NOT BE EQUAL.

THE TEST STATISTIC, H, IS DISTRIBUTED AS CHI-SQUARE WITH A-1 DEGREES OF FREEDOM.

THIS TEST DOES NOT INCLUDE THE CORRECTION TERM FOR TIES (GIVEN IN SOKAL AND ROHLF, P. 389) SINCE OTHER SOURCES DO NOT USE IT.

THIS TEST IS AS EFFICIENT AS WILCOXAN'S SIGN TEST FOR A=2. SEE SOKAL AND ROHLF, PP. 387-391; STEEL AND TORRIE, PP. 406-407 FOR DETAILS OF THE TEST.

THE STANDARD REFERENCES FOR THIS WORKSPACE ARE:

STEEL AND TORRIE PRINCIPLES AND PROCEDURES OF STATISTICS (1960) MCGRAW-HILL PUBL.CO.

SNEDECOR AND COX STATISTICAL METHODS (1967) 6TH EDITION IOWA UNIV. PRESS

SOKAL AND ROHLF BIOMETRY-THE PRINCIPLES AND PRACTICE OF STATISTICS IN BIOLOGICAL RESEARCH (1969) FREEMAN AND CO.

LIB 14 PSTAT
J.A. REDFIELD; DEPT OF ZOOLOGY; UNIV. OF ALBERTA

THE WORKSPACE 'PSTAT' CONTAINS FUNCTIONS TO BE USED IN CONJUNCTION WITH PARAMETRIC DATA.

THE FOLLOWING FUNCTIONS ARE AVAILABLE:

V TTEST1 P

TTEST1 COMPUTED 'T' FOR A SERIES OF PAIRED OBSERVATIONS, REPRESENTED BY THE VECTORS V AND P. THE PROGRAM RETURNS SAMPLE SIZE, DEGREES OF FREDOM, MEANS, POOLED VARIANCE, POOLED STANDARD DEVIATION, POOLED STANDARD ERROR AND T, ALL WITH SUITABLE LABELS.

THE FORMULA USED FOR THE CALCULATION OF T IS:

$$T = \frac{\bar{D}}{S_{\bar{D}}}$$

WHERE

$\bar{D}$=MEAN DIFFERENCE

$S_{\bar{D}}$=STANDARD ERROR OF MEAN DIFFERENCE

SEE SNEDECOR AND COX (PAGES 92-95) OR STEEL AND TORRIE (PAGES 78-79) FOR FURTHER DETAILS

V TTEST2 P

TTEST2 COMPUTES 'T' FOR AN UNPAIRED SERIES OF EQUAL SAMPLE SIZED OBSERVATIONS, REPRESENTED BY THE VECTORS V AND P. THE PROGRAM RETURNS THE SAMPLE SIZES, POOLED VARIANCE, POOLED STANDARD DEVIATION, POOLED STANDARD ERROR OF THE MEAN DIFFERENCE, AND T IN A SUITABLE FORMAT.

THE FORMULA USED FOR THE CALCULATION OF T IS:

$$T = \frac{\bar{V} - \bar{P}}{S_{\bar{V}-\bar{P}}}$$

SEE SNEDECOR AND COX OR STEEL AND TORRIE
FOR FURTHER DETAILS OF THIS CALCULATION.

```
      V TTEST3 P
```

TTEST3 COMPUTES 'T' FOR A SERIES OF UNPAIRED OBSERVATIONS NOT NECESSARILY OF THE SAME SAMPLE SIZE. THESE OBSERVATIONS ARE REPRESENTED BY THE VECTORS V AND P. THIS PROGRAM ASSUMES EQUALITY OF VARIANCES. IF YOU DO NOT WANT TO ASSUME THIS, USE TTEST4. THE PROGRAM RETURNS THE SAMPLE SIZES, MEANS, VARIANCES, STANDARD DEVIATIONS, STANDARD ERRORS, POOLED VARIANCE, STANDARD ERROR OF THE MEAN DIFFERENCE, AND T, ALL WITH SUITABLE LABLES.

THE FORMULA USED FOR THE CALCULATION OF T IS:

$$T=\frac{\bar{V}-\bar{P}}{S_{\bar{V}-\bar{P}}}$$

WHERE

$\bar{V}$=MEAN OF V

$\bar{P}$=MEAN OF P

$S_{\bar{V}-\bar{P}}$=STANDARD ERROR OF THE MEAN DIFFERENCE

SEE SNEDECOR AND COX (PAGES 104-105) OR STEEL AND TORRIE (PAGES 73-75) FOR FURTHER DETAILS OF THIS CALCULATION.

```
      V TTEST4 P
```

TTEST4 COMPUTES T' FOR AN UNPAIRED SERIES OF SAMPLES FROM TWO POPULATIONS. THIS TEST DOES NOT ASSUME EQUALITY OF VARIANCES. YOU WILL BE REQUIRED TO ENTER THE VALUE OF T FOR N-1 AND M-1 DEGREES OF FREEDOM (N=NUMBER OF ELEMENTS IN V AND M=NUMBER OF ELEMENTS IN P) FOR THE CHOSEN SIGNIFICANCE LEVEL (THESE VALUES ARE TO BE OBTAINED FROM A TABLE OF T). THIS PROGRAM RETURNS SAMPLE SIZES, MEANS, VARIANCES, STANDARD DEVIATIONS, STANDARD ERRORS, POOLED STANDARD ERROR OF THE MEAN DIFFERENCE, T' AND THE VALUE THAT T' MUST EXCEED IN ORDER TO BE SIGNIFICANT AT THE CHOSEN LEVEL OF SIGNIFICANCE.

THE FORMULA USED IN THIS CALCULATION IS:

$$T = \frac{\bar{D}}{S_{\bar{D}}}$$

WHERE

$\bar{D}$ = MEAN DIFFERENCE

$S_{\bar{D}}$ = STANDARD ERROR OF THE MEAN DIFFERENCE

FOR FURTHER DETAILS ON THIS CALCULATION SEE SNEDECOR AND COX (PAGES 114-116) OR STEEL AND TORRIE (PAGES 81-82).

LIB 15 INTERPO
D.A.COOK, DEPT. PHARMACOLOGY, UNIV. OF ALBERTA

'INTERPOLATE' IS A ROUTINE FOR LINEAR INTERPOLATION.

THE LEFT HAND ARGUMENT REPRESENTS A VECTOR OF VALUES OF X FOR WHICH VALUES OF Y MUST BE OBTAINED BY LINEAR INTERPOLATION; THE RIGHT HAND ARGUMENT IS A MATRIX OF TWO COLUMNS, THE FIRST COLUMN OF WHICH REPRESENTS THE ESTABLISHED VALUES OF X AND THE SECOND COLUMN REPRESENTS THE ESTABLISHED VALUES OF Y. THE RESULT IS A VECTOR OF THE SAME SIZE AS THE LEFT HAND ARGUMENT COMPRISING THE CORRESPONDING VALUES OF Y.

IF A VALUE IN THE LEFT HAND ARGUMENT IS GREATER THAN THE LARGEST ESTABLISHED VALUE OF X, OR SMALLER THAN THE SMALLEST ESTABLISHED VALUE OF X, THE RESULT DEPENDS ON THE VALUE OF THE LOCAL VARIABLE 'SET' ESTABLISHED IN THE FIRST STATEMENT OF 'INTERPOLATE'. IF 'SET' IS ¯1, THE RESULT IS SET TO AN EMPTY VECTOR, A MESSAGE TO THE EFFECT THAT A VALUE WHICH IS OUT OF RANGE HAS BEEN ENCOUNTERED, WILL BE PRINTED, AND EXECUTION TERMINATES. IF SET IS PUT TO 0, THE FIRST OR LAST PAIR OF POINTS IN THE ESTABLISHED VALUES ARE EXTRAPOLATED TO ACCOMODATE THE VALUE WHICH IS OUT OF RANGE, GIVING A RESULT OF THE SAME LENGTH AS THE LEFT ARGUMENT. IF SET IS PUT AT 1, THE POINTS WHICH FALL OUT OF RANGE ARE IGNORED; A RESULT WHICH IS SHORTER THAN THE LEFT HAND ARGUMENT BY THE NUMBER OF VALUES WHICH FALL OUT OF RANGE IS PRODUCED. UNLESS CHANGED BY THE USER, THE FIRST STATEMENT OF 'INTERPOLATE' PUTS THE VARIABLE 'SET' AT 0.
'INTERPOLATE' REQUIRES 'LSQPLOT'.

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LIB 15 PCF
E.M.EDWARDS, ELECT. ENGR., UNIV. OF ALBERTA

    PCF WILL FIT A POLYNOMIAL TO A SET OF DATA POINTS
 USING THE LEAST SQUARES CRITERION OF FIT.

 R←N PCF X

    N IS THE ORDER OF THE POLYNOMIAL.
    X IS A 2,K MATRIX CONSISTING OF K DATA POINTS.
(THE INDEPENDENT VARIABLE REPRESENTED BY THE FIRST
ROW OF X IS TAKEN TO BE EXACT.)  THE FIT MINIMIZES
DEVIATIONS OF THE DEPENDENT VARIABLE REPRESENTED BY
THE SECOND ROW.
    R IS A VECTOR OF THE POLYNOMIAL COEFFICIENTS IN
DESCENDING ORDER.
    THE GLOBAL DEV IS INTERNALLY SET TO THE RMS DEVIATION
CATENATED WITH THE MAX DEVIATION AND THE VALUE OF THE
INDEPENDENT VARIABLE AT WHICH IT OCCURRED.
```

LIB 20 IGDS
V.CASAROSA, E.D'ETTORRE, G. FACONTI, S.TRUMPY

THIS WORKSPACE CONTAINS AN INTERACTIVE SET OF FUNCTIONS HAVING THREE MAIN TASKS:

1) IT FIT TROUGH A SET OF GIVEN POINTS A SURFACE HAVING GIVEN SLOPES IN THE BOUNDARY POINTS;
2) IT INTERPOLATES MORE POINTS ON SUCH SURFACE;
3) IT DISPLAYS THE BUILT SURFACE ON A GRAPHIC DEVICE.

THE GRAPHIC DEVICES HOLDED BY THE SYSTEM ARE:

1) TEKTRONIX COMPUTER DISPLAY TERMINAL
2) PLOTTER HP7201-A ON-LINE WITH THE TERMINAL.

THE SYSTEM WORKS UNDER THE CONTROL OF A SUPERVISOR FUNCTION WHICH ASKS THE USER FOR COMMANDS, PERFORMS THE SYNTACTICAL ANALYSIS AND EXECUTES THE INPUT LINE IF IT IS FOUND CORRECT.

ALL PARAMETERS AND COMMANDS MUST BE GIVEN FROM THE TERMINAL KEYBOARD.

THE SET OF AVAILABLE COMMANDS IS SHOWN BELOW:

BUILD	TO BUILD A SURFACE
CHANGE	TO CHANGE THE PARAMETERS OF A GIVEN SURFACE
DISPLAY	TO DISPLAY A SURFACE ON THE 2250 DISPLAY UNIT OR ON THE TEKTRONIX TERMINAL
END	TO CLOSE THE WORK SESSION
PLOT	TO PLOT A SURFACE ON THE PLOTTER HP7201-A
RESTORE	TO RELOAD THE PARAMETERS OF A SURFACE SAVED WITH THE COMMAND SAVE
SAVE	TO WRITE THE PARAMETERS OF THE BUILT SURFACE ON A CMS FILE
STORE	TO ASSIGN TO AN APL VARIABLE OR TO WRITE ON A CMS FILE THE PARAMETERS OF A DISPLAYED SURFACE
WRITE	TO WRITE IN EBCDIC CODE THE PARAMETERS OF A GIVEN SURFACE ON A CMS FILE

MORE INFORMATION ON THE IGDS SYSTEM CAN BE FOUND IN THE CNUCE TECHNICAL REPORT N.84 'IGDS: INTERACTIVE DESIGN OF INTERPOLATED SURFACES'.

LIB 21 APLGRAPH
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00'

YOU HAVE AT DISPOSAL THE FOLLOWING WORKSPACES:

WORKSPACE	NATURE OF CONTENTS
APLGRAPH	STANDARD FUNCTIONS
MINI	MINI PACKAGE
EGM	4015 ENHANCED GRAPHICS MODULE SUPPORT
EXAMPLES	DEMONSTRATION PROGRAMS
ARBOUT	ARBITRARY OUTPUT FACILITY
TEK2741	APL\360 INTERFACE SUPPORT FOR STANDARD PACKAGE
MINI2741	APL\360 INTERFACE SUPPORT FOR MINI PACKAGE

THE DISTRIBUTED WORKSPACES CAN BE USED TO IMPLEMENT THREE DIFFERENT SOFTWARE PACKAGES:

PACKAGE	CAPABILITY SUMMARY	TEKTRONIX TERMINAL
STANDARD FUNCTION PACKAGE	PRIMARY GRAPHIC FUNCTIONS POINT PLOTTING DASHED LINES VIRTUAL GRAPHICS	4013 4015
MINI PACKAGE	SUB-SET OF THE STANDARD FUNCTION PACKAGE. UPWARD COMPATIBLE TO THE STANDARD FUNCTION PACKAGE. SUPPORTS PRIMARY FUNCTIONS	4013 4015
ENHANCED GRAPHIC PACKAGE	FOUR KINDS OF DASHED LINES 4096×4096 ADDRESSABLE SCREEN UNITS. POINT PLOT VECTORS USING HARDWARE	4015 ONLY WITH EGM HARDWARE

STANDARD FUNCTION PACKAGE AND MINI FUNCTION PACKAGE HAVE BEEN IMPLEMENTED IN '21 STDNPACK' AND IN '21 MINIPACK' RESPECTIVELY.
ENHANCED GRAPHIC PACKAGE IS NOT SUPPORTED BY THE 2741 TERMINAL INTERFACE.
THE DOCUMENTATION ON APL GRAPH-II IS AVAILABLE AT CNUCE BOOKSTORE.

LIB 21 ARBOUT
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00' FOR FURTHER INFORMATION, SEE 21 APLGRAPH DOCUMENTATION.

LIB 21 EGM
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00' FOR FURTHER INFORMATION, SEE 21 APLGRAPH DOCUMENTATION.

LIB 21 EXAMPLES
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00' FOR FURTHER INFORMATION, SEE 21 APLGRAPH DOCUMENTATION.

LIB 21 MINI
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00' FOR FURTHER INFORMATION, SEE 21 APLGRAPH DOCUMENTATION.

LIB 21 MINIPACK
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00'
FOR FURTHER INFORMATION, SEE 21 APLGRAPH DOCUMENTATION.

LIB 21 MINI2741
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00'
FOR FURTHER INFORMATION, SEE 21 APLGRAPH DOCUMENTATION.

LIB 21 STDNPACK
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00'
FOR FURTHER INFORMATION, SEE 21 APLGRAPH DOCUMENTATION.

LIB 21 TEK2741
TEKTRONIX DISTRIBUTED

LIBRARY 21 CONTAINS APL GRAPH-II PACKAGE AS DESCRIBED IN THE 'APL GRAPH-II USER'S MANUAL - DOCUMENT NO. 062-1617-00'
FOR FURTHER INFORMATION, SEE 21 APLGRAPH DOCUMENTATION.

LIB 22 PAINT
E. FABRI, INST. OF PHISICS (PISA)

FUNCTIONS TO PLOT A MATRIX OF GIVEN POINTS AT THE TERMINAL.

THE GROUP *PLOT* IN THE WORKSPACE *PAINT* CONTAINS THE FUNCTIONS *FIPLO* , *PAINT* AND *NEWPLOT*, WITH THE AUXILIARY VARIABLES *ΔQΔ* AND *TT*.

SYNTAX:

```
      FIPLO B
      PAINT B
Z←A NEWPLOT B
```

B IS A TWO-COLUMN MATRIX. B[;1] IS THE VECTOR OF THE ABSCISSAE (IN ANY ORDER); B[;2] IS THE VECTOR OF THE CORRESPONDING ORDINATES.

A IS A TWO-COMPONENT VECTOR. A[1] IS THE X-SCALE (IN CM PER UNIT); A[2] IS THE Y-SCALE.

Z IS A CHARACTER VECTOR, INCLUDING BLANKS AND CARRIAGE RETURNS, WHOSE PRINTOUT WILL PRODUCE THE REQUIRED PLOT.

FIPLO COMPUTES AUTOMATICALLY THE X AND Y SCALES GIVING A MESSAGE ERROR WHEN THE GRAPH EXCEEDS THE PAPER WIDTH.

PAINT IS AN INTERACTIVE FUNCTION REQUEARING TO THE USER THE X AND Y SCALES IN CM. PER UNIT.

WHEN NEWPLOT IS CALLED BY PAINT, ITS RESULT IS ASSIGNED TO THE GLOBAL VARIABLE *ΔPLOT*, AND DIRECTLY PRINTED. THE PLOT MAY BE REPEATED, IF NEEDED, BY TYPING ΔPLOT.

THE GLOBAL VARIABLE TT MUST BE SET TO 1 USING A CORRESPONDENCE TYPEWRITER AND MUST BE SET TO 2 USING A SELECTRIC TYPEWRITER.

LIB 22 PLOT
IBM DISTRIBUTED

THE PLOT WORKSPACE CAN BE USED TO PRINT GRAPHS, HISTOGRAMS, AND FORMATED NUMERICAL ARRAYS AND MATRICES.

THE WORKING FUNCTIONS IN THIS WORKSPACE ARE:

AND DFT EFT PLOT VS

THE FORMATTING FUNCTIONS DFT AND EFT PROVIDE A FORMATTING CAPABILITY EQUIVALENT TO THE FORMATTING FUNCTION ⍕. DFT AND EFT ARE, HOWEVER, INCLUDED IN THIS WORKSPACE TO PROVIDE COMPATIBILITY WITH PREVIOUS PLOTFORMAT DISTRIBUTIONS.

THE NAMES AND COMPOSITION OF THE GROUPS IN THIS WORKSPACE ARE:

DFTGP: AND DFT
EFTGP: AND EFT
PLOTGP: AND PLOT VS

SYNTAX	DESCRIPTION
Z←A AND B	ESSENTIALLY A COLUMN-CATENATOR, WITH SOME EXTRA EFFECTS WHEN THE ARGUMENTS ARE NOT MATRICES. THIS FUNCTION IS DESIGNED TO BE USED EITHER INDEPENDENTLY, OR IN CONJUNCTION WITH VS. TOGETHER, THEY PROVIDE A CONVENIENT WAY OF FORMING INPUT TO THE PLOT FUNCTION.
Z←A DFT B	FORMS FIXED-POINT OUTPUT.
Z←A EFT B	FORMS EXPONENTIAL OUTPUT.
A PLOT B	GRAPHS ONE OR MORE FUNCTIONS SIMULTANEOUSLY.
Z←A VS B	ESSENTIALLY A COLUMN-CATENATOR, SIMILAR TO AND, EXCEPT THAT THE RIGHT-HAND ARGUMENT MUST BE OF RANK ≤ 1. IT IS DESIGNED PRIMARILY TO PROVIDE CONVENIENT FORMATION OF INPUT TO PLOT FUNCTION. WHETHER USED BY ITSELF OR WITH AND, VS WILL CAUSE ITS RIGHT ARGUMENT TO APPEAR AS THE LEFTMOST COLUMN OF THE RESULTANT ARRAY. (THE RESULTANT WILL BE AN ARRAY OF RANK THREE, CONSISTING OF A SINGLE PLANE).

BOTH AND AND VS WILL WORK WITH EITHER 1 OR 0-ORIGIN INDEXING.

-HOW TO USE PLOT

THE FUNCTION PLOT WILL GRAPH ONE OR MORE FUNCTIONS SIMULTANEOUSLY, AUTOMATICALLY SCALING THE VALUES TO FIT APPROXIMATELY WITHIN SCALE DIMENSIONS SPECIFIED BY THE USER. IT WILL WORK ONLY IN 1-ORIGIN INDEXING.

THE FORM IN WHICH PLOT IS USED IS:

SCALESIZE PLOT FUNCTION

LEFT ARGUMENT: ONE OR TWO NUMBERS.

FIRST NUMBER SPECIFIES THE APPROXIMATE SIZE OF THE VERTICAL AXIS AND THE SECOND NUMBER DOES THE SAME FOR THE HORIZONTAL AXIS.

IF ONLY ONE NUMBER IS SUPPLIED, IT IS APPLIED TO BOTH AXES.

THERE IS NO BUILT-IN LIMIT TO THE DIMENSIONS, AND A HORIZONTAL AXIS LARGER THAN THE WORKSPACE WIDTH WILL CAUSE SOME POINTS TO BE PRINTED ON THE NEXT LOWER LINE.

RIGHT ARGUMENT: A RECTANGULAR ARRAY WITH RANK ≤ 3.

SCALAR: WILL BE TREATED AS A VECTOR OF LENGTH ONE.

VECTOR: WILL BE PLOTTED AS ORDINATE AGAINST ITS OWN INDICES AS ABSCISSA.

MATRIX: THE LEFTMOST COLUMN WILL BE TAKEN AS THE ABSCISSA AND ALL OTHER COLUMNS WILL BE PLOTTED AS ORDINATES. A DIFFERENT PLOTTING SYMBOL UP TO THE NUMBER OF SYMBOLS AVAILABLE WILL BE USED FOR EACH COLUMN. IN CASE TWO ORDINATES HAVE A COMMON POINT, THE SYMBOL FOR THE COLUMN FURTHEST TO THE RIGHT WILL BE USED.

3-DIMENSIONAL ARRAY: THE FIRST PLANE WILL BE PLOTTED AS A MATRIX, AND ALL OTHER PLANES WILL BE DISREGARDED.

AUXILIARY FUNCTIONS: THE FUNCTIONS AND AND VS CAN BE USED TO GENERATE THE RIGHT ARGUMENT IN THE PROPER FORM FOR PLOT. FOR EXAMPLE:

```
      20 PLOT Z AND Y VS X
```

PLOT CHARACTERS: THE SYMBOLS USED ARE ASSIGNED TO THE VARIABLE PC IN LINE 1 OF PLOT. THE ALPHABET SUPPLIED IS '○*•▽Δ□'. THIS ALPHABET MAY BE EXTENDED AND MODIFIED AS DESIRED, USING THE NORMAL FUNCTION-EDITING PROCEDURES: EITHER CHANGE LINE 1 OF THE FUNCTION, OR DELETE IT AND INDEPENDENTLY SPECIFY A VALUE FOR PC.

HISTOGRAMS: PLOT CAN BE USED TO GENERATE HISTOGRAMS BY SETTING THE VARIABLE HS TO 1 IN LINE 2 OF THE FUNCTION. ALTERNATIVELY, LINE 2 CAN BE DELETED, AND HS CAN BE SET EXTERNALLY.

-HOW TO USE DFT AND EFT

THE FUNCTIONS DFT AND EFT WILL FORMAT NUMBERS IN DECIMAL AND EXPONENTIAL FORM, RESPECTIVELY, FOR TABULAR OUTPUT. THEY MAY BE USED TO GENERATE IMMEDIATE OUTPUT, OR TO STORE AN IMAGE FOR LATER PRINTING. THE TWO FORMS ARE:

```
      PATTERN  DFT  TABLE
      PATTERN  EFT  TABLE
```

AND

```
IMAGE←PATTERN  DFT  TABLE
IMAGE←PATTERN  EFT  TABLE
```

RIGHT ARGUMENT: AN ARRAY TO BE FORMATTED.

IT MUST BE NUMERICAL, AND OF RANK ≤ 3. THE FIRST PLANE OF A 3-DIMENSIONAL ARRAY WILL BE TREATED AS A MATRIX, AND ALL OTHER PLANES WILL BE DISREGARDED. ARRAYS OF HIGHER RANK WILL BE SIGNALLED AS A 'RANK PROBLEM.'

LEFT ARGUMENT: ONE OR MORE INTEGERS TO CONTROL THE FORMAT.

A SINGLE INTEGER:

DFT: SPECIFIES THE NUMBER OF DIGITS TO THE RIGHT OF THE DECIMAL POINT IN DECIMAL FORMAT.

EFT: SPECIFIES THE NUMBER OF SIGNIFICANT DIGITS IN EXPONENTIAL FORMAT.

COLUMNS WILL BE SPACED UNIFORMLY, WITH SPACING SUCH THAT THERE WILL BE AT LEAST ONE SPACE BETWEEN THE CLOSEST NUMBERS.

A PAIR OF INTEGERS: THE FIRST SPECIFIES THE TOTAL NUMBER OF SPACES TO BE ALLOCATED TO EACH COLUMN, AND THE SECOND IS USED AS ABOVE.

DFT: THE FIRST NUMBER MUST BE AT LEAST TWO LARGER THAN THE SECOND.

EFT: THE FIRST NUMBER MUST BE AT LEAST SIX LARGER THAN THE SECOND.

MORE THAN ONE PAIR OF INTEGERS: THERE MUST BE ONE PAIR FOR EACH COLUMN OF OUTPUT (OR EACH ELEMENT OF A VECTOR). EACH PAIR WILL BE INTERPRETED AS ABOVE, AND WILL APPLY TO THE LAYOUT OF THE CORRESPONDING COLUMN.

LIB 22 PLOTHP
G.FACONTI

LE FUNZIONI DELLO SPAZIO DI LAVORO 'PLOTHP' FORNISCONO IL MEZZO PER OTTENERE OUTPUT GRAFICI CON L'UTILIZZO DI UN PLOTTER HP7201A.

LE FUNZIONI PRINCIPALI SONO:
OUT
PLWR.

OUT XY E' UNA FUNZIONE MONADICA CHE PUO' AVERE COME ARGOMENTO:
1. LE SEQUENZE DI CARATTERI 'PLTL' (PLOT LINES) OPPURE 'PLTP' (PLOT POINTS), PER ATTIVARE IL MODO GRAFICO;
2. LA MATRICE (C1 ASCISSE E C2 ORDINATE) DELLE COORDINATE DEI PUNTI DA DISEGNARE;
3. LA SEQUENZA DI CARATTERI 'PLTT' PER CHIUDERE IL MODO GRAFICO.

VOLENDO CIOE' DISEGNARE UNA MATRICE DI PUNTI DETTA XY, OCCORRE DARE IN SEQUENZA I SEGUENTI COMANDI:
OUT 'PLTL' ('PLTP')
OUT XY
OUT 'PLTT'.

A PLWR STRING E' UNA FUNZIONE DIADICA CHE HA COME ARGOMENTO DESTRO UNA STRINGA DI CARATTERI DA PLOTTARE E COME ARGOMENTO SINISTRO UN VETTORE DI TRE COMPONENTI CHE RAPPRESENTANO RISPETTIVAMENTE LE COORDINATE X ED Y DEL PUNTO DI INIZIO DELLA STRINGA E LA SCALA CON CUI LA STRINGA DEVE ESSERE PLOTTATA. LA TERZA COMPONENTE PUO' ESSERE OMESSA ED IN TAL CASO IL FATTORE DI SCALA PER LA STRINGA E' POSTO AD UNO.

LE FUNZIONI DELLO SPAZIO DI LAVORO SONO RAGGRUPPATE IN UN GRUPPO CHIAMATO 'PLOPAC'.

LIB 23 CURVE2D
S. TRUMPY

FUNCTIONS FOR FITTING A PLAN CURVE THROUGHT A SET OF GIVEN POINTS, TO INTERPOLATE ON SUCH CURVE MORE POINTS AND FOR PLOTTING THEM AT THE TERMINAL.

THE CURVE IS A SEQUENCE OF CUBIC SEGMENTS PASSING THROUGH THE GIVEN POINTS WITH FIRST AND SECOND CONTINUOUS DERIVATIVES. THE MATHEMATICAL MODEL IS DERIVED FROM : COONS S.A. 'SURFACES FOR COMPUTER AIDED DESIGN OF SPACE FORMS MAC-TR-G1' M.I.T.,MASSACHUSSET,1967 . THERE IS ALSO THE WAY OF PLOTTING THE RESULTING SET OF POINTS ON THE TERMINAL.
IN ORDER TO OBTAIN A FINE PLOT THE USER IS SUPPOSED TO HAVE THE PLOTTING ELEMENT: 1167114.
THE FOLLOWING FUNCTIONS ARE AVAILABLE:

SETDATA NIHILADIC
THIS INTERACTIVE FUNCTION ASKS THE PROGRAMMER THE COORDINATES OF THE GIVEN POINTS, THEN REQUIRES THE COMPONENTS OF THE TANGENTS TO THE CURVE IN THE INITIAL AND IN THE FINAL POINT.THE MODULE OF THE TANGENTS MAY BE ZERO.

CURVILINEO NIHILADIC
THIS FUNCTION HAS AS INPUT THE GLOBAL VARIABLES POINTS ,TI AND TF AND PUTS IN THE GLOBAL VARIABLE CURVA THE REPREHESENTATION OF THE SPACE CURVE WITH ALL COMPUTED INTERNAL TANGENTS.

INTER N MONADIC
THE VALUE OF THE FUNCTION INTER IS THE SET OF COORDINATES OF THE INTERPOLATED POINTS OBTAINED INSERTING N-1 POINTS BETWEEN EACH COUPLET OF SUBSEQUENT GIVEN POINTS PLUS THE GIVEN POINTS TOO.THE POINTS ARE ORDERED IN SUCH WAY THAT THEY RUN SEQUENTIALLY ALONG THE CURVE FROM THE FIRST GIVEN POINT TO THE LAST ONE.

PAINT R MONADIC
THIS INTERACTIVE FUNCTION PROVIDES THE WAY OF PLOTTING ON THE TERMINAL THE MATRIX OF POINTS R RESULTING FROM INTER. THE USER IS SUPPOSED TO HAVE THE PLOTTING ELEMENT 1167114.

LIB 23 CURVE3D
S. TRUMPY

FUNCTIONS FOR FITTING A SPACE CURVE THROUGHT A SET OF GIVEN POINTS, TO INTERPOLATE ON SUCH CURVE MORE POINTS AND FOR PLOTTING THEM AT THE TEPMINAL.

THE SPACE CURVE IS A SEQUENCE OF CUBIC SEGMENTS PASSING THROUGH THE GIVEN POINTS WITH FIRST AND SECOND CONTINUOUS DERIVATIVES. THE MATHEMATICAL MODEL IS DERIVED FROM : COONS S.A. 'SURFACES FOR COMPUTER AIDED DESIGN OF SPACE FORMS MAC-TR-G1' M.I.T.,MASSACHUSSET,1967 . THERE IS ALSO THE WAY OF PLOTTING THE RESULTING SET OF POINTS IN AN ISOMETRIC PROJECTION ON THE TERMINAL.
IN ORDER TO OBTAIN A FINE PLOT THE USER IS SUPPOSED TO HAVE THE PLOTTING ELEMENT: 1167114.

SETDATA NIHILADIC
THIS INTERACTIVE FUNCTION ASKS THE PROGRAMMER THE COORDINATES OF THE GIVEN POINTS, THEN REQUIRES THE COMPONENTS OF THE TANGENTS TO THE CURVE IN THE INITIAL AND IN THE FINAL POINT.THE MODULE OF THE TANGENTS MAY BE ZERO.

CURVILINEO NIHILADIC
THIS FUNCTION HAS AS INPUT THE GLOBAL VARIABLES POINTS ,TI AND TF AND PUTS IN THE GLOBAL VARIABLE CURVA THE REPPRESENTATION OF THE SPACE CURVE WITH ALL COMPUTED INTERNAL TANGENTS.

INTER N MONADIC
THE VALUE OF THE FUNCTION INTER IS THE SET OF COORDINATES OF THE INTERPOLATED POINTS OBTAINED INSERTING N-1 POINTS BETWEEN EACH COUPLET OF SUBSEQUENT GIVEN POINTS PLUS THE GIVEN POINTS TOO.THE POINTS ARE ORDERED IN SUCH WAY THAT THEY RUN SEQUENTIALLY ALONG THE CURVE FROM THE FIRST GIVEN POINT TO THE LAST ONE.

A XYZ P DYADIC
THE VALUE OF THE FUNCTION XYZ IS A MATRIX OF POINTS HAVING TWO COORDINATES DERIVED AS AN ISOMETRIC PROJECTION FROM THE COORDINATES OF THE POINTS COMPUTED BY THE FUNCTON INTER. A IS A VECTOR OF TWO ELEMENTS : A[1]=1 OR 2 OR 3 IF THE AXIS TO BE DROPPED IS RESPECTIVELY X , Y OR Z ; A[2] IS THE ANGLE IN DEGREES WHICH THE AXIS DROPPED FORMS WITH THE ORIZONTAL AXIS. P IS THE VALUE OF THE FUNCTION INTER .

PAINT R MONADIC
THIS INTERACTIVE FUNCTION PROVIDES THE WAY OF PLOTTING ON THE TERMINAL THE MATRIX OF POINTS R RESULTING FROM XYZ. THE USER IS SUPPOSED TO HAVE THE PLOTTING ELEMENT 1167114.

LIB 23 POLY

G.W.STOCKTON, CHEM.DEPT. U.OF.A.

WORKSPACE POLY CONTAINS A POLYNOMIAL LEAST-SQUARES PROGRAM OF GENERAL UTILITY. IT WILL FIT A DATA SET IN Y TO A POLYNOMIAL IN X WITH ALL THE ERROR IN Y.

EXECUTION BEGINS ON TYPING START.

THE PROGRAM REQUIRES AN INPUT DATA SET IN X~Y VALUES AND THE ERROR(S) IN Y (WHICH MAY BE 0). IF ONLY ONE ERROR-VALUE IS ENTERED, IT WILL BE APPLIED TO ALL Y-VALUES. INPUT IS BY ENTERING ALL THE X VALUES ON ONE OR MORE LINES (THE QUESTION MORE? WILL BE ASKED AFTER EACH LINE) FOLLOWED BY ALL THE Y VALUES AND ALL THE ERRORS. DATA IS REQUESTED BY THE PROGRAM BEFORE EACH ENTRY.

VALUES DERIVED FROM THE DATA SET MAY BE OBTAINED BEFORE THE LEAST-SQUARES FIT, EG. A FIT OF LOG10 X VS. 1/Y MAY BE OBTAINED. THE CODE NUMBERS 0 THROUGH 8 ARE USED TO LABEL THESE OPTIONAL FUNCTIONS. (A CORRESPONDENCE LIST IS PRINTED BY THE PROGRAM). FOR EXAMPLE, 1 5 GIVES LOG10 1/X; 5 1 GIVES 1/LOG10 X; 0 LEAVES THE DATA SET UNCHANGED (NOTE THAT FUNCTIONS ARE CALCULATED IN THE ORDER THE LABELS WERE ENTERED).

QUESTIONS REQUIRE THE REPLIES Y FOR YES AND N FOR NO.

A GRAPHICAL PLOT OF THE DATA SET [AS +] AND THE REGRESSION LINE [AS •] IS OPTIONAL AND IS AUTOMATICALLY SCALED TO FIT THE PAGE.

A NOTE ABOUT ERROR :

THE SUM-OF-SQUARES OF RESIDUALS AND STANDARD DEVIATIONS OF THE REGRESSION COEFFICIENTS REFLECT ONLY THE 'GOODNESS' OF LEAST-SQUARES FIT TO A PARTICULAR POLYNOMIAL. THEY IN NO WAY REFLECT THE ERROR IN EXPERIMENTAL OBSERVATIONS (IE. THE DATA SET IN X~Y) TO BE FITTED. FOR THIS REASON, A SET OF INTUITIVELY (OR OTHERWISE) DERIVED ERRORS IN Y-VALUES MAY BE GIVEN AS INPUT TO THE PROGRAM. THE DATA SET IS THEN WEIGHTED INVERSELY AS THE SQUARE OF THESE ERRORS; THUS POINTS WITH A HIGH ERROR CARRY A LOWER WEIGHT. THE SO CALLED STANDARD ERROR IS CALCULATED IN THE SAME WAY AS THE STANDARD DEVIATION WITH THE EXCEPTION THAT THE SUM-OF-SQUARES OF RESIDUALS IS AUGMENTED BY THE SUM-OF-SQUARES OF ERRORS. THUS, THE STANDARD DEVIATION SHOWS GOODNESS OF FIT; THE STANDARD ERROR REFLECTS THE EXPERIMENTAL ERROR AND IS A MODIFIED STANDARD DEVIATION.

USEFUL FUNCTIONS WITHIN THE PROGRAM :

THE FUNCTION LSQ IS THE ACTUAL POLYNOMIAL FITTING PROGRAM. IT MAY BE USED WITHIN ANY OTHER PROGRAM AS FOLLOWS:

A LSQ B WHERE A IS THE POLYNOMIAL ORDER AND B IS A (3,N) MATRIX CONAINING THE Y,X,AND ERROR VECTORS AS ITS 3 ROWS. THE FUNCTION RETURNS A (3,(A+1)) MATRIX CONTAINING THE REGRESSION COEFFICIENTS, THEIR STANDARD DEVIATIONS, AND STANDARD ERRORS AS THE 3 ROWS.

LSQ REQUIRES THE MATRIX INVERSION FUNCTION INVERT.

THIS WORKSPACE ALSO CONTAINS A FUNCTION DET FOR THE EVALUATION OF DETERMINANTS, USED AS FOLLOWS : DET M , WHERE M IS A SQUARE MATRIX, RETURNS THE DETERMINANT.

FOR A DETAILED WRITE UP OF THE PROGRAM AND ITS ALGORITHM, PLEASE CONTACT THE AUTHOR.

```
LIB 23 SPLINE3
B. PETRUSCHKA DVZ,GFK KARLSRUHE

 IN THIS WORKSPACE THERE ARE FUNCTIONS FOR THE SMOOTHING
 OF DATA BY CUBIC SPLINE FUNCTIONS IN THE CASE IN WHICH THE
 FORM OF THE UNDERLYING FUNCTION IS NOT KNOWN A PRIORI.

 SPLINEFIT CALLS THE FUNCTION SMOOTH,WHICH FURNISHES THE
 COEFFICIENTS OF THE SPLINE FUNCTION:
 F←A[I]+(B[I]×(X-X[I]))+(C[I]×(X-X[I])*2)+D[I]×(X-X[I])*3
 WITH   X[I]≤X<X[I+1].
 THE SMOOTHING FUNCTION F WAS CONSTRUCTED SUCH,THAT IT MINI-
 MIZES THE MEAN SQUARE CURVATURE UNDER THE CONDITION:
 SUM OF ERROR SQUARES LESS ÈQUAL A GIVEN NUMBER S(S≥0).
 THE PROGRAM SMOOTH IS A MODIFIED A P L VERSION OF THE ALGOL
 PROGRAM IN C.H.REINSCH:SMOOTHING BY SPLINE FUNCTIONS
            NUM.MATH.10,177-183(1967).
 (SEE ALSO H.SPAETH:SMOOTH,GFK KARLSRUHE PROGRAMMBESCHR.144)
 PROGRAM CALL:    SPLINEFIT
 THE USER MUST ENTER THE DATA,WEIGHTS AND A VALUE FOR S,WHICH
 DEPENDS ON THE RELATIVE WEIGHTS(SEE REINSCH).IN THE FOLLOWING
 HE HAS TO TYPE IN YES OR NO ON QUESTIONS TYPED
 OUT.IF HE WANTS THE CALCULATION OF VALUES OF THE FUNCTION IN
 POINTS DIFFERING FROM THE GIVEN DATA,HE HAS TO ENTER A
 DISTANCE:DELTA.THE PROGRAM THEN FURNISHES AUTOMATICALLY THE
 VALUES OF F IN THE POINTS,WHICH ARE DEFINED BY SUBDIVIDING
 THE INTERVAL[X[1],X[N]] OF THE GIVEN DISTINCT POINTS BY THE
 DISTANCE DELTA.
 THE USER MAY HAVE ALSO A PLOT OF THE CALCULATED FUNCTION.
 THE MEANING OF THE SYMBOLS o AND * ARE:
 o     GIVEN DATA
 *     CALCULATED FUNCTION VALUES
```

LIB 23 SURFACES
S. TRUMPY

IN THIS WORKSPACE THERE IS AN INTERACTIVE SET OF FUNCTIONS HAVING TWO MAIN TASKS: 1) IT FITS THROUGH A SET OF GIVEN POINTS A BI-CUBIC SURFACE HAVING GIVEN SLOPES IN THE BOUNDARY POINTS: 2) IT INTERPOLATES MORE POINTS ON SUCH SURFACE.

THE GIVEN POINTS MUST LIE ON THE INTERSECTION OF TWO FAMILIES OF CROSSING IMAGINARY CURVES. THESE SPACE CURVES ARE CALLED: CURVES AND STRINGERS. CURVES ARE CONSTITUTED BY INPUT POINTS CONSECUTIVELY SEQUENCED BY THE CORRESPONDING CURVE POINTS CONNECTED IN THE OTHER DIRECTION. THE MATHEMATICAL MODEL IS DERIVED FROM: COONS S.A. 'SURFACES FOR COMPUTER AIDED DESIGN OF SPACE FORMS MAC-TR-G1' M.I.T. MASSACHUSSET, 1967. THERE IS ALSO THE WAY OF PLOTTING THE RESULTING SET OF POINTS IN AN ISOMETRIC PROJECTION ON THE TERMINAL. IN ORDER TO OBTAIN A FINE PLOT THE USER IS SUPPOSED TO HAVE THE PLOTTING ELEMENT NUMBER: 1167114.
FUNCTION DESCRIPTION:

SETPOINTS NIHILADIC
THIS INTERACTIVE FUNCTION REQUIRES THE USER THE DIMENSION OF THE GRID OF POINTS AND THE COORDINATES OF THE GIVEN POINTS IN THE PROPER ORDER.

SETTANGENTS NIHILADIC
THIS INTERACTIVE FUNCTION REQUIRES THE USER THE COMPONENTS OF THE GIVEN TANGENTS TO THE BOUNDARY POINTS IN THE DIRECTION OF THE CURVES AND OF THE STRINGERS. THE MODULE OF THE GIVEN TANGENTS MAY BE ZERO.

COONS NIHILADIC
HAVING AS INPUT THE GLOBAL VARIABLES SET UP BY PREVIOUSLY MENTIONED FUNCTIONS, COONS PUT IN THE GLOBAL VARIABLE PATCHES THE REPRESENTATION OF THE SURFACE WITH ALL COMPUTED INTERNAL TANGENTS.

A FIT B DYADIC
THE VALUE OF THE FUNCTION FIT IS THE SET OF INTERPOLATED POINTS OBTAINED BY INTERSECTING TWO FAMILIES OF CURVES: THE FIRST ONE IS FORMED BY B-1 CURVES INTERPOLATED BETWEEN EACH COUPLET OF SUBSEQUENT GIVEN CURVES AND GIVEN CURVES TOO; THE SECOND ONE IS FORMED BY A-1 STRINGERS INTERPOLATED BETWEEN EACH COUPLET OF SUBSEQUENT GIVEN STRINGERS AND GIVEN STRINGERS TOO. THE POINTS ARE ORDERED SO THAT THEY DESCRIBE THE SURFACE WITH A SERIES OF CONSECUTIVE CURVES.

A XYZ P DYADIC
THE VALUE OF THE FUNCTION XYZ IS A MATRIX OF POINTS HAVING TWO COORDINATES DERIVED AS AN ISOMETRIC PROJECTION FROM THE

COORDINATED OF THE POINTS COMPUTED BY THE FUNCTION FIT. A IS A VECTOR OF TWO ELEMENTS: A⌈ 1 ⌉= 1 OR 2 OR 3 IF THE AXIS TO BE DROPPED IS RESPECTIVELY X, Y OR Z; A ⌈ 2 ⌉ IS THE ANGLE IN DEGREES WHICH THE AXIS DROPPED FORMS WITH THE ORIZONTAL AXIS. P IS THE VALUE OF THE FUNCTION INTER.

PAINT R *MONADIC*

THIS INTERACTIVE FUNCTION PROVIDES THE WAY OF PLOTTING ON THE TERMINAL THE MATRIX OF POINTS R RESULTING FROM XYZ. THE USER IS SUPPOSED TO HAVE THE PLOTTING ELEMENT 1167114.

LIMAR 30.1

LIB 30 LIMAR
V.CASAROSA, G.FACONTI, S.TRUMPY

THE WORKSPACE LIMAR CONTAINS FUNCTIONS TO MANIPOLATE RATIONAL EXPRESSIONS. THE SYSTEM WORKS UNDER THE CONTROL OF THE SUPERVISOR FUNCTION 'SUPER', WICH ADVISES THE USER TO BE READY BY WRITING THE CHARACTERS:

***

FROM THIS POINT ANY SEQUENCE ENTERED AT THE KEYBOARD IS CHECKED AS BEING CORRECTED AS:

1) A LIMA-R EXPRESSION OR
2) AN EXPRESSION CONTAINING EPI-OPERATORS OR
3) A SYSTEM COMMAND.

LIMA-R EXPRESSIONS ARE RATIONAL PARENTHETIZED EXPRESSIONS WITHOUT ANY PRECEDENCE AMONG THE OPERATORS + - × ÷ *, WHOSE ATOMIC ELEMENTS MAY BE CONSTANTS OR VARIABLES NAMES. A CORRECTED EXPRESSION IS TYPED BACK AT THE TERMINAL.
THE EPI-OPERATORS ARE OPERATORS INVOLVING THE MANIPOLATION OF LIMA-R EXPRESSIONS. THEY ARE:

1- ASSIGNEMENT
2- SUBSTITUTION
3- EVALUATION.

TO PERFORM AN ASSIGNEMENT THE SYMBOL '←' IS USED.
EXEMPLE:

```
X1←A+B
```

WITHIN A LIMA-R EXPRESSION IT IS POSSIBLE TO SUBSTITUTE A NAME WITH A NEW EXPRESSION. THE SUBSTITUTION BODY IS DELIMITED BY BRAKETS.
EXEMPLES:

```
X1←A×B
X1[A←3;B←K+L]
RESULT: 3×K+L
X1[C←AA;[A←C]]
RESULT: AA×B
```

THE EPI-OPERATOR '∈' PRODUCES THE EVALUATION OF THE EXPRESSION APPEARING ON ITS RIGHT:

1- RECOGNIZING THE LIMA-R EXPRESSION AS AN EXPRESSION OF THE TYPE KNOWN BY THE SYSTEM
2- EXECUTING ALL THE ARITHMETIC OPERATIONS AND SEMPLIFICATIONS THAT LIMA-R PERFORMS ON THE RECOGNIZED EXPRESSIONS.

THE SET OF AVAILABLE COMMANDS IS SHOWN BELOW:

)CLEAR (ERASES ANY DEFINED EXPRESSION)
)EXPR (LISTS ALL THE STORED EXPRESSIONS)
)ATOMS (LISTS THE NAMES OF ALL ATOMIC VARIABLES)
)CONST (GIVE THE LIST OF NUMERICAL OPERANDS)
)DISPLAY (DISPLAYS THE EXPRESSIONS WHOSE NAMES ARE SPECIFIED AS PARAMETERS)
)ERASE (ERASES THE EXPRESSIONS WHOSE NAMES ARE SPECIFIED AS PARAMETERS)
)STOP (LEAVES THE CONTROL OF THE LIMA-R SUPERVISOR)

)SAVE (SAVES THE WORKSPACE AS CONTINUE ON THE A-DISK WITHOUT LEAVING THE LIMA-R SUPERVISOR)
)OFF HOLD (PRODUCES EXIT FROM THE CONTROL OF THE LIMA-R SUPERVISOR AND APL INTERPPETER)
)OFF (CLOSES THE TERMINAL SESSION)
WHEN MISTAKES ARE MADE, THE LIMA-R SUPERVISOR PRINT AT TERMINAL ERROR MESSAGES.
THE LIMA-R SYSTEM IS DOCUMENTED IN A TECHNICAL REPORT AVAILABLE AT CNUCE BOOKSTORE.

LIB 31 CHECK
G. WILHELMI DVZ KFZ KARLSRUHE

CHECKS FOR A LEGAL APL EXPRESSION

THE FOLLOWING COMMAND IS AVAILABLE: PREP.
THIS IS A PROGRAM TO MANIPULATE AND TRANSFORM APL EXPRESSIONS USING THE OPERATORS + - × ÷ * ⍟ ○ ! AND ANY LEGAL APL VARIABLES AND CONSTANTS. THIS PROGRAM SHOULD BE USEFUL IN PREPARATION OF EXPRESSIONS FOR DIFERENTIATION. AT PRESENT YOU CAN CHECK THE SYNTAX OF YOUR EXPRESSION, FRAS SUPERFLUOUS PARENTHESIS AND PLOT A GRAPHIC PICTURE OF THE TREE STRUCTURE OF YOUR EXPRESSION.

LIB 31 DERIVE
G. WILHELMI DVZ KFZ KARLSRUHE

DIFERENTIATES A LEGAL APL EXPRESSION

THE WORKSPACE DERIVE CONTAINS THE FUNCTION ∇Z←X D F∇ TO DIFFERENTIATE A LEGAL APL EXPRESSION CONTAINED IN THE CHARACTERSTRING F USING THE OPERATORS + - × ÷ * ⍟ ○ AND ANY APL VARIABLES AND CONSTANTS. THE DIFFERENTIATION VARIABLE MUST BE CONTAINED IN THE CHARACTER-STRING X.NO BLANKS ARE PERMITTED IN X AND F. AS RESULT THE DIFFERENTIATED EXPRESSION IS CONTAINED IN THE CHARACTERSTRING Z AND THE GLOBAL VARIABLE DEUN.
THE EXPRESSION X IS LIABLE TO FOLLOWING RESTRICTIONS :
  NO SUPERFLUOUS PARENTHESIS ARE ALLOWED :
  NO MULTIPLE PARENTHESIS
  NO PARENTHESIS AROUND IDENTIFIERS(CONSTANT OR VARIABLE)
  NO MULTIPLE)
  NO) AT THE RIGHT END OF THE EXPRESSION.
IF YOU ARE NOT SURE ABOUT CORRECTNESS OF SYNTAX OR PARENTSESIS YOU MAY CONSULT PROGRAM PREP IN WORKSPACE CHECK IN THIS LIBRARY.

LIB 32 COMPLEX
E.M. EDWARDS, W.R. TINGA; E.E. DEPT; U. OF ALBERTA

'COMPLEX' IS A WORKSPACE DESIGNED TO SIMPLIFY COMPLEX NUMBER ARITHMETIC UNDER APL.

THE FOLLOWING 'STRUCTURING' OPERATIONS ARE AVAILABLE IN THE PACKAGE:

SYNTAX	DESCRIPTION
R←X PJ Y	CONVERTS REAL STRUCTURES X AND Y INTO THE COMPLEX STRUCTURE, R, WITH REAL AND IMAGINARY PARTS X AND Y RESPECTIVELY. SEE BELOW.
R←RS X	CONVERTS THE REAL PART OF A COMPLEX STRUCTURE, X, INTO ITS REAL STRUCTURE EQUIVALENT
R←CS X	CONVERTS A REAL STRUCTURE,X, INTO COMPLEX NOTATION

ARITHMETIC OPERATIONS INCLUDED ARE:

SYNTAX	DESCRIPTION
R←RE X	REAL PART OF X IN COMPLEX NOTATION
R←IM X	IMAGINARY PART OF X IN COMPLEX NOTATION
R←ABS X	ABSOLUTE VALUE OF X IN COMPLEX NOTATION
R←ARG X	ARGUMENT OF X IN RADIANS IN COMPLEX NOTATION
R←CONJ X	COMPLEX CONJUGATE OF X
R←JS X	MULTIPLIES A COMPLEX STRUCTURE BY THE SQUARE ROOT OF ¯1
R←X CADD Y	SUM OF X AND Y
R←X CADD-Y	DIFFERENCE OF X AND Y
R←X CMUL Y	PRODUCT OF X AND Y
R←X CDIV Y	QUOTIENT OF X AND Y
R←X CPWR Y	X TO THE POWER Y
R←CEXP X	NATURAL EXPONENT OF X
R←CLOG X	NATURAL LOGARITHM OF X
R←POLAR X	TRANSFORMS CARTESIAN TO POLAR COORDINATES
R←XY X	TRANSFORMS X FROM POLAR TO CARTESIAN COORDINATES

NOTES: 1)ALL FUNCTIONS, EXCEPT CS, TREAT 'ONE ELEMENT' ARRAYS AS IF THEY WERE FIRST RE-STRUCTURED BY CS
2)ALL ARITHMETIC MUST BE DONE IN XY COORDINATES.

THE SYSTEM USES AN 'ORDERED PAIR' NOTATION FOR COMPLEX STRUCTURES. ANY REAL STRUCTURE, X, MAY BE TRANSFORMED INTO AN EQUIVALENT COMPLEX STRUCTURE BY USING THE OPERATOR CS ON IT. THE NEW STRUCTURE WOULD HAVE ZEROS IN ITS IMAGINARY PART. IF Z←CS X,

THEN ⍴Z WILL BE 2,⍴X AND ⍴⍴Z WILL BE 1+⍴⍴X.

TO ENTER A COMPLEX STRUCTURE, Z, FIRST DEFINE TWO REAL STRUCTURES X AND Y EQUAL TO THE REAL AND IMAGINARY PARTS OF Z RESPECTIVELY. THEN TYPE:

```
Z←X PJ Y
```

COMPLEX SCALARS ARE MORE EASILY ENTERED DIRECTLY AS A TWO ELEMENT VECTOR. FOR EXAMPLE X=2+J3 IS ENTERED AS X←2 3.

FOLLOWING ARE A FEW EXAMPLES:

	REAL STRUCTURE	*COMPLEX EQUIVALENT*
SCALAR:	`3`	`3 0`
VECTOR:	`1 2 3`	`1 2 3` `0 0 0`

MATRIX:	`1 2`
	`3 4`
		`1 2`
		`3 4`
		
		`0 0`
		`0 0`

FOLLOWING ARE EXAMPLES WHICH ILLUSTRATE SOME OF THE OPERATIONS.

X	*OPERATION*	*RESULT*
`1 2` `3 4`	*RS X*	`1 2`
`1 2 3` `4 5 6`	*RE X*	`1 2 3` `0 0 0`
`1 2` `3 4`	*JS X*	`¯3 ¯4` `1 2`
`3 4`	*ABS X*	`5 0`
`1 2 3` `4 5 6`	`1` *CADD X*	`2 3 4` `4 5 6`
`3 4`	*POLAR X*	`5 0.927295218`

LIB 32 INFINITE
V. CASAROSA, G. FACONTI, S. TRUMPY

THIS WORKSPACE PROVIDES THE USER WITH ARITHMETIC AND LOGICAL OPERATIONS USING NUMBERS WICH ARE OVER 16 DIGITS LONG.

THE ARGUMENTS REQUIRED BY ALL THE FUNCTIONS ARE NUMERICAL VECTORS OF DECIMAL DIGITS.
THE FUNCTIONS IMPLEMENTED ARE:

Z←N1 INFDIV N2	EVALUATES QUOTIENT AND REMAINDER OF N1 DIVIDED BY N2 (INFINITE NUMBERS). N2 CANNOT BE ZERO. Z IS IN THE FORM (⍴Q),Q,(⍴R),R.
Z←N1 INFEQ N2	COMPARES N1 AND N2. Z IS LOGICAL, 1 IF N1=N2, ZERO OTHERWISE.
Z←INFFACT N	INFINITE FACTORIAL. N IS A NUMERICAL VECTOR WHOSE COMPONENTS MUST BE ≤9. IT IS NOT USED BY LIMAR BUT CAN BE USEFUL.
Z←N1 INFGT N2	COMPARES N1 AND N2. Z IS LOGICAL, 1 IF N1>N2, ZERO OTHERWISE.
Z←N1 INFLT N2	COMPARES N1 AND N2. Z IS LOGICAL, 1 IF N1<N2, ZERO OTHERWISE.
Z←N1 INFMUL N2	Z IS PRODUCT OF INFINITE NUMBERS N1 AND N2. Z,N1 AND N2 ARE NUMERICAL VECTORS. IF WE GET WS FULL WE MAY USE INFMUL2 WHICH IS SLOWER BUT TAKES LESS MEMORY. IF EITHER IS ZERO, RESULT IS ZERO.
Z←N1 INFMUL2 N2	SEE INFMUL.
Z←N1 INFPOW N2	Z IS N1 POWER N2. Z,N1 AND N2 ARE NUMERICAL VECTORS.
Z←N1 INFSUB N2	Z IS THE DIFFERENCE OF INFINITE NUMBERS N1 AND N2.
Z←N1 INFSUM N2	Z IS THE SUM OF INFINITE NUMBERS N1 AND N2.

LIB 32 LOGIC
KETTLEWELL - LITCHFIELD, ELECT. ENGR, U OF ALBERTA

LOGIC IS AN EXPERIMENTAL WORKSPACE DESIGNED TO FACILITATE THE REDUCTION OF BOOLEAN RELATIONS TO MINIMAL FORM.

∇R←DC BMIN F

BMIN ACCEPTS A LOGICAL RANK 2 PARTIAL TABLE OF COMBINATIONS F, WHICH CONSISTS OF ONLY THOSE COMBINATIONS OF A SINGLE-OUTPUT BOOLEAN FUNCTION WHICH YIELD A '1' OUTPUT. BMIN ALSO CONSIDERS THE LAST DC ENTRIES IN THE TABLE AS 'DON'T CARES' (⍬'S) AND EXERCISES ITS OPTION IN USING THESE ENTRIES IN THE MINIMIZATION PROCESS. OUTPUT FROM BMIN IS A CHARACTER STRING REPRESENTING THE MINIMAL BOOLEAN SUM-OF-PRODUCTS FORM OF THE FUNCTION EMBODIED IN THE TABLE OF COMBINATIONS. TO REDUCE THE FUNCTION

A	B	C	Z
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	⍬
1	1	0	0
1	1	1	⍬

A PARTIAL TABLE OF COMBINATIONS T IS FORMED AS

```
0 1 0
1 0 0
1 0 1
1 1 1
```

GROUPING ALL OF THE ⍬ TERMS LAST. SINCE THERE ARE 2 SUCH TERMS BMIN IS INVOLKED AS 2 BMIN T
AND RETURNS THE CHARACTER RESULT $\underline{A}B\underline{C} + A\underline{B}$ IN MINIMAL SUM-OF-PRODUCTS FORM.

∇R←N DTB A

DTB CONVERTS THE INTEGER PART OF EACH ELEMENT OF THE NUMERIC ARRAY A TO ITS N BIT 2'S COMPLEMENT BINARY REPRESENTATION SUCH THAT ⍴R = (⍴A),N DTB IS PRIMARILY INTENDED FOR GENERATING THE LOGICAL PARTIAL TABLE OF COMBINATIONS USED BY BMIN. IN THE EXAMPLE THE ROWS OF T ARE THE 3 BIT BINARY

REPRESENTATIONS OF 2 4 5 7 RESPECTIVELY. THEREFORE T CAN BE GENERATED BY T ← 3 DTB 2 4 5 7 .
BMIN CAN NOW BE INVOLKED BY 2 BMIN T
OR BY 2 BMIN 3 DTB 2 4 5 7

∇R←SN BTD B

BTD CONVERTS THE BINARY REPRESENTATION OF THE LOGICAL ARRAY B TO ITS DECIMAL INTEGER VALUES. SN SHOULD BE 0 FOR 2'S COMPLEMENT (SIGNED) CONVERSION AND 1 FOR 1'S COMPLEMENT (UNSIGNED) CONVERSION.

0 BTD T WILL YIELD 2 ¯4 ¯3 ¯1 *AND*
1 BTD T WILL YIELD 2 4 5 7

LIB 33 DIFF1
D.A.JOHNSTON;E.E DEPT; U. OF ALBERTA

DIFF1 IS A DERIVATIVE ROUTINE FOR POINT DATA.

R←DIFF1 X

AT THE END POINTS IT EVALUATES THE SLOPE OF THE STRAIGHT LINE TO THE ADJACENT POINT, AND AT INTERIOR POINTS IT TAKES THE SLOPE OF A PARABOLA PASSING THROUGH THAT POINT AND THE TWO ADJACENT POINTS.

X MUST BE A MATRIX. THE FIRST LINE IS TREATED AS A SET OF ABSCISSA POINTS. THERE MUST BE TWO OF MORE AND THEY SHOULD BE IN ORDER. ANY SPACING IS ACCEPTABLE BUT TWO POINTS MUST NOT BE THE SAME.

THE COLUMN BELOW EACH ABSCISSA POINT IS A VECTOR OF VALUES OF ANY NUMBER OF FUNCTIONS AT THAT POINT. R IS A MATRIX OF THE SAME SIZE AS X, WITH THE SAME ABSCISSA POINTS IN THE FIRST ROW AND VALUES OF THE DERIVATIVE OF THE FUNCTIONS AT THOSE POINTS IN THE OTHER ROWS. THE SECOND DERIVATIVE IS GIVEN BY:DIFF1 DIFF1 X.

LIB 33 EXTREMA
E.M. EDWARDS; E.E. DEPT.; U. OF ALBERTA

THIS WORKSPACE USES A GRID REFINEMENT METHOD TO LOCATE THE MAXIMUM OF A DEFINED FUNCTION OVER A SPECIFIED INTERVAL.

AN APL DESCRIPTION, CALLED FCN, OF THE FUNCTION IN QUESTION IS REQUIRED FCN IS A USER DEFINED, RESULT RETURNING, MONADIC FUNCTION RETURNING A VECTOR RESULT FROM A VECTOR ARGUMENT.

```
     ∇R←FCN X
[1]  'DEFINITION OF FUNCTION OF X'
     ∇
```

XM←MAX I

THE RESULT RETURNED BY MAX IS THE ARGUMENT, X, SUCH THAT FCN X IS THE LARGEST VALUE OF FCN ON THE INTERVAL I[1 2] WITHIN A TOLERANCE ON X OF + OR - I[3]×|I[1]-I[2]|. IF I IS ONLY TWO ELEMENTS, I[3] WILL BE SUPPLIED AS 1E¯6. THE REFINEMENT PROCESS WILL STOP WHEN EITHER THE ERROR LIMIT IS REACHED OR THE RESOLUTION OF THE MACHINE IS UNABLE TO DISTINGUISH BETWEEN TWO OR MORE ADJACENT VALUES. THE VARIABLE MAX (NUMBER OF ADJACENT IDENTICAL VALUES) WILL BE >1 IF THE LATTER IS THE CASE.

MAX WILL ADVISE IF THE MAXIMUM FOUND IS AT AN END POINT OF THE INTERVAL.

MAX WILL PRINT A MESSAGE AND TERMINATE WITHOUT RETURNING A RESULT IF A MULTIPLE MAXIMUM IS FOUND.

FOR MINIMA, FIND THE MAXIMUM OF -F(X).

LIB 33 FOURIER
D.H. KELLY; E. E. DEPT.; U. OF ALBERTA

TWO ROUTINES CALLED FOURIER1 AND FOURIER2 ARE AVAILABLE TO FIND FOURIER COEFFICIENTS.

R←H FOURIER1 X

FOURIER1 IS A PROGRAM THAT RETURNS THE FOURIER COEFFICIENTS DESCRIBING THE DATA INPUT. ITS OUTPUT FORM IS

0	I	I+1	.....
D.C. COMP	A(I)	A(I+1)	.....
PERIOD	B(I)	B(I+1)	.....

WHERE A(I) IS THE COSINE COEFFICIENT OF THE ITH HARMONIC AND B(I) THE SINE COEFFICENT FOR THE SERIES

F(T)=D.C. COMP+SUM(A(I)COS(IWT)+B(I)SIN(IWT))

X IS THE INPUT DATA IN THE FORM OF A 2×N MATRIX WITH THE FIRST ROW COMPRISING THE TIMES T AND THE SECOND ROW THE CORRESPONDING FUNCTION VALUES. H IS A CONTROL.

IF H=2, ALL A AND B ARE RETURNED
(I.E. USE FOR FUNCTION SPECIFIED OVER THE RANGE 0 TO 2×PI)
H=1, ODD A AND B ARE RETURNED
(I.E. USE FOR FUNCTION SPECIFIED OVER THE RANGE 0 TO PI)
H=.5, ODD B ARE RETURNED
(I.E. USE FOR FUNCTION SPECIFIED OVER THE RANGE 0 TO PI÷2)

THE PROGRAM NORMALLY RETURNS THE HARMONICS FROM 1 TO ¯2+⌊(⍴T)÷H. HOWEVER, IF H IS SPECIFIED AS A TWO ELEMENT VECTOR WITH H[1]=.5,1, OR 2, THE RESULT WILL BE THE HARMONICS FROM 1 TO H[2]. FOR ⍴H=3 AND H[1] AS BEFORE, THE RESULT WILL BE THE HARMONICS FROM H[2] TO H[3].

EXAMPLE: R←2 10 20 FOURIER1 X
RETURNS ALL COSINE AND SINE COEFFICIENTS FOR THE HARMONICS FROM 10 TO 20

THE OUTPUT OF FOURIER1 IS COMPATIBLE WITH THE REQUIREMENTS OF FOURIERINV.

```
H FOURIER2 M
```

FOURIER2 CALCULATES THE FOURIER COEFFICIENTS, A[N] AND B[N], OF A DEFINED FUNCTION:

```
FFUN X= SUM A[N]COS NX + B[N] SIN NX     N=1,2,3,...
```

THE PROGRAM USES A 6-POINT GAUSS QUADRATURE IN EACH OF N OR 2×N INTERVALS OVER THE RANGE 0 TO H×PI WHERE H=2,1 OR 0.5. THE FUNCTION IS DEFINED BY:

```
∇FFUN[1]Z←' FUNCTION OF X OVER RANGE 0 TO H×PI ' ∇
```

TO OPERATE, TYPE:

```
H FOURIER2 M
```

WHERE M IS A 2 ELEMENT VECTOR SUCH THAT M[1] IS THE LOWEST HARMONIC DESIRED (M[1]≥1) AND M[2] IS THE HIGHEST HARMONIC DESIRED (M[2]≥M[1]).

```
OUTPUT IS IN FOURIERDATA IN A (2,M[2]+1)MATRIX
D.C. A[1] A[2].....
     B[1] B[2].....
```

IF FOURIERSWITCH≠0, A PRINTOUT WILL BE GIVEN IN THE FORM:

```
D.C. COMPONENT=
HARMONIC      MAGNETUDE(DB)      PHASE(DEG)

  M[1]           ......             ......
   ..              ...                ...
  M[2]            .....              ....
```

THE ABOVE ARE ROUNDED TO 2 DECIMAL PLACES AND ¯1000 DB INDICATES 0 MAGNITUDE. FOR H=2 D.C. AND ALL HARMONICS FROM M[1] TO M[2] ARE FOUND. FOR H=1, ODD HARMONICS ONLY. FOR H=0.5, ODD B[N] ONLY.

RESULTS FOR A SQUARE WAVE GIVE ERRORS OF THE ORDER OF 1E¯15 AND TIMES:

```
H=2; T=0.05+0.2×((M[2]*2)+M[1]*2)+M[1]+M[2]   SECONDS
  1; T=0.03+0.05×APPROX THE ABOVE TERMS
0.5; T=0.05+0.026×APPROX THE ABOVE
```

FOURIERINV IS A PROGRAM DESIGNED TO BE USED WITH FOURIER. IT RETURNS A VECTOR OF VALUES OF THE SERIES CORRESPONDING TO THE TIMES REPRESENTED BY T. THE CALL IS

```
R← T FOURIERINV F
```

WHERE T IS A VECTOR OF THE TIMES FOR WHICH THE SERIES IS TO BE EVALUATED AND F IS THE SET OF FOURIER COEFFICIENTS IN THE FORM PROVIDED BY FOURIER1 OR FOURIER2. F IS PRESENTLY FOURIERDATA.

LIB 33 INTEGRAL
D.H.KELLY, E.M.EDWARDS, W.R.TINGA; E.E.DEPT; U.OF ALBERTA

THIS WORKSPACE CONTAINS TWO METHODS TO EVALUATE
THE INTEGRAL OF A DEFINED FUNCTION OVER A
GIVEN RANGE.

```
      R←INTEGRAL1 X
```

INTEGRAL1 IS A TRAPEZOIDAL OR SIMPSON'S RULE INTEGRATION ROUTINE FOR POINT DATA. X IS A MATRIX WHOSE FIRST ROW IS THE INDEPENDENT VARIABLE POINT VALUES AND WHOSE SUBSEQUENT ROW(S) ARE THE CORRESPONDING VALUES OF THE DEPENDENT VARIABLE(S). IF POSSIBLE, USE AN ODD NUMBER OF EQUALLY SPACED POINTS. THIS WILL RESULT IN THE USE OF SIMPSONS RULE INSTEAD OF THE TRAPEZOID RULE.

IF AN EVEN NUMBER OF EQUALLY SPACED POINTS IS USED, THE TRAPEZOID RULE IS USED FOR THE LAST INTERVAL AND SIMPSON'S RULE IS USED FOR THE REMAINDER.

```
      R←M INTEGRAL2 X
```

INTEGRAL2 USES A 6-POINT LEGENDRE-GAUSS ROUTINE TO EVALUATE THE INTEGRAL OF A DEFINED FUNCTION OVER A GIVEN RANGE, (A,B). THE RANGE MAY BE SUBDIVIDED INTO M MAJOR INTERVALS FOR IMPROVED ACCURACY.

AN APL FUNCTION DESCRIPTION OF THE INTEGRAND CALLED 'FCTN' IS REQUIRED. FCTN IS A USER DEFINED, RESULT RETURNING, MONADIC FUNCTION.

```
      ∇R←FCTN X
      [1]  'DEFINITION OF FUNCTION OF X'∇
```

ACCURACY OF INTEGRATION IS ALWAYS 6 DECIMAL PLACES UNLESS AN ABSOLUTE ERROR LIMIT IS SPECIFIED BY THE USER (SEE BELOW). THE FUNCTION INTEGRAL2 WILL SOLVE MORE SOPHISTICATED PROBLEMS BY A PROCEDURE DESCRIBED BELOW.

MORE DETAILS:

M CAN BE SPECIFIED AS A 1, 2 OR 3-ELEMENT VECTOR.

1) THE FIRST ELEMENT, M[1], ALWAYS DENOTES THE INITIAL NO. OF MAJOR INTERVALS OVER WHICH THE INTEGRATION TAKES PLACE.

2) THE SECOND ELEMENT, M[2] IS THE ABSOLUTE ERROR LIMIT THE USER DESIRES, E.G., '5 0.001 INTEGRAL2 0 3.14' RETURNS THE RESULT OF THE VALUE OF THE INTEGRAL OF F(X) BETWEEN 0 AND 3.14 OVER AT LEAST 5 MAJOR INTERVALS (EQUIVALENT TO A 5×6=30 POINT-EVALUATION), TO AN ACCURACY OF AT LEAST 3 DECIMAL PLACES.

THE INTEGRAL IS EVALUATED USING THE USER SPECIFIED M[1]. M[1] IS ITERATIVELY DOUBLED AND THE INTEGRATION REPEATED UNTIL THE DIFFERENCE BETWEEN CONSECUTIVE INTEGRATIONS IS LESS THAN M[2]. THE GLOBAL MMAX IS SET TO THE LARGEST VALUE OF M[1] USED.

THE INTERNAL ACCURACY CHECK CAN BE BYPASSED BY SETTING

M[2]=0. *INTEGRATION IS THEN PERFORMED ONCE WITH THE USER SPECIFIED VALUE FOR* M[1].

3) *THE INTEGRATION MAYBE PERFORMED IN LESS WORKSPACE AT THE COST OF MORE TIME BY SETTING* M[3]<<M[1]. *E.G., A* 1000 *MAJOR INTERVAL INTGRATION MAY BE ACHIEVED BY USING* M←1000 0 20.

THE ARGUMENT X OF FCTN IS ALWAYS A 6×*N MATRIX. FCTN MUST ALWAYS RETURN A STRUCTURE, R, SUCH THAT* ⍴R←→6×M×... . *MULTIPLE FUNCTION INTEGRATION IS POSSIBLE BY USING '∘.OP' IF DUE REGARD IS GIVEN TO THE ABOVE DIMENSION REQUIREMENT ON R.*

```
LIB 33 MPF
R.B.RODEN, E.A.BUCHHEIT,COMP. SCI. DEPT,U. OF WATERLOO

  MATHEMATICAL PHYSICS FUNCTIONS

  NOTE: ANY FUNCTION ARGUMENT NOT ENDING WITH THE LETTER 'V'
 MUST BE A SCALAR OR ONE-ELEMENT VECTOR, THOSE ENDING WITH
 'V' MAY BE A SCALAR OR MORE THAN ONE-ELEMENT VECTOR.

    R ← N BESX XV
  BESSEL FN FOR INTEGER ORDER ⌈N⌉ AND ARGUMENTS ⌈XV⌉

    R ← NV BESN X
  BESSEL FN FOR INTEGER ORDERS ⌈NV⌉ AND ARGUMENT ⌈X⌉

    R ← NF FBES XV
  BESSEL FN FOR FRACTIONAL, BUT NOT NEGATIVE INTEGER, ORDER
⌈NF⌉ AND ARGUMENTS ⌈XV⌉.  IF NF≠INTEGER, THEN XV≥0.

    R ← NF FBESL XV
  SAME AS ⌈FBES⌉, THOUGH SLOWER, BUT WILL WORK ON LARGE
VALUES OF XV>15 AND N>25 WHERE ⌈FBES⌉ GIVES A (DOMAIN ERROR)

    R ← N SBES XV
    R ← N SBESL XV
  SPHERICAL BESSEL FNS FOR INTEGER ORDER ⌈N⌉ AND POSITIVE
ARGUMENTS ⌈XV⌉  (XV>0). USE ⌈FBES⌉ AND ⌈FBESL⌉ RESP.

  ⌈BESX⌉,⌈BESN⌉ USE THE INTEGRAL FORM OF THE INTEGER ORDER
BESSEL FN.  ⌈FBES⌉ SUMS THE FIRST (OR 30 IF 10≤⌈/XV) TERMS
IN THE POWER SERIES OF THE BESSEL FN.  ⌈FBESL⌉ SUMS TERMS
UNTIL A TERM < 1E¯12 × CURRENT SUM IS ENCOUNTERED.
ACCURACY: AT LEAST 8 SIGNIFICANT DIGITS (EXCEPT NEAR ZEROS)
IF ORDER≤40  AND  ARGUMENTS≤50.


    R ← ERF XV
  ERROR FUNCTION FOR ARGUMENTS ⌈XV⌉. ACCURACY: AT LEAST 10
SIG DIGITS FOR 0≤XV≤3

    R ← N HERMITE XV
  HERMITE POLYNOMIAL FOR NON-NEGATIVE INTEGER ORDER ⌈N⌉ AND
ARGUMENTS ⌈XV⌉

    R ← N LAGUERRE XV
  LAGUERRE POLYNOMIAL FOR NON-NEGATIVE INTEGER ORDER ⌈N⌉ AND
ARGUMENTS ⌈XV⌉

    R ← N LEGENDRE XV
  LEGENDRE POLYNOMIAL FOR NON-NEGATIVE INTEGER ORDER ⌈N⌉ AND
```

ARGUMENTS [XV]

R ← PSI X
PSI FUNCTION FOR POSITIVE ARGUMENT [X] (X>0). REQUIRES GLOBAL VARIABLE [Z] WHICH CONTAINS VALUES OF THE RIEMANN ZETA FUNCTIONS.

SOURCE: APL ⍞ II(6),APL ALGORITHM 49.

LIB 33 TRESP
S.U.H. QURESHI; E.E.DEPT; U. OF ALBERTA

GIVEN A RATIONAL RESPONSE FUNCTION Y, TRESP FINDS THE OUTPUT IN THE TIME DOMAIN AT INSTANTS SPECIFIED IN TIME, USING THE STATE VARIABLE APPROACH.

```
R←Y TRESP TIME
```

THE RESPONSE FUNCTION Y IS TO BE SPECIFIED AS A SINGLE MATRIX THE TWO ROWS OF WHICH REPRESENT THE COEFFICIENTS OF THE NUMERATOR AND DENOMINATOR POLYNOMIALS, RESPECTIVELY, OF A RATIONALIZED RATIONAL RESPONSE FUNCTION,I.E. THE COEFFICIENT OF THE HIGHEST POWER OF S IN THE DENOMINATOR IS ALWAYS UNITY. FOR EXAMPLE

$$\text{INPUT}\times\text{TRANSFER FUNC.} = \frac{S + 1}{S(2(S*2) + 3S + 4)} \quad \text{IS REPRESENTED BY}$$

```
Y←2 4 ⍴ 0 0 0.5 0.5 1 1.5 2 0
```

TIME IS A VECTOR OF INSTANTS OF TIME AT WHICH THE OUTPUT IS DESIRED. FOR TIMES GREATER THAN 2 SECONDS THE FUNCTION RETURNS A RESULT ONLY FOR VALUES THAT ARE MULTIPLES OF 0.1 SEC.

TRESP RETURNS A VECTOR AS THE RESULT.

THE GLOBALS USED BY TRESP ARE AS FOLLOWS:

DIGAC - IS THE NUMBER OF DIGITS TO WHICH THE RESULT IS ACCURATE. ITS NOMINAL WORKSPACE VALUE IS 5.

TRCON - IS A VECTOR OF TWO ELEMENTS, THE FIRST ELEMENT GIVES THE NUMBER OF TERMS TAKEN IN THE FIRST SERIES APPROXIMATION OF THE FUNDAMENTAL MATRIX, THE SECOND GIVES THE NUMBER OF TERMS ADDED TO ATTAIN THE DESIRED DEGREE OF ACCURACY. ITS NOMINAL VALUE IS 10 5 .

LIB 34 GILL

D.H. KELLY; E.E.DEPT.; U. OF ALBERTA

GILL IS A RUNGE KUTTA ROUTINE FOR SOLVING A SET OF DIFFERENTIAL EQUATIONS OF THE FORM:

DX/DT=AX+DM+N

A, D, M AND N ARE MATRICES DEFINED IN SET (SEE BELOW) AND MAY BE NONLINEAR OR TIME VARYING. THE CALL IS:

```
T GILL X
```

WHERE T IS A 5 TERM VECTOR WITH T[1] = INITIAL TIME, T[2] = FINAL TIME, T[3] = INITIAL TIME INCREMENT, T[4] = MINIMUM TIME INCREMENT, AND T[5] = ACCURACY CRITERION.

THE OUTPUT IS STORED IN GILLDATA AS COLUMNS OF T AND X VALUES.

GILL COMPUTES EACH STEP TWICE, USING 2 HALF STEPS ON THE SECOND ROUND. A COMPARISON IS MADE AND IF THE DIFFERENCE EXCEEDS T[5] THE STEP SIZE IS REDUCED BY A FACTOR OF 2. THIS IS REPEATED UNTIL THE ERROR IS ≤T[5] OR UNTIL THE STEP REACHES THE MINIMUM SET BY T[4] WHICH IS THEN USED. IF THE ERROR IS ≤T[5]÷10 THE STEP SIZE IS DOUBLED OTHERWISE THE STEP SIZE IS UNCHANGED.

THE COEFFICIENTS DEFINED IN SET MAY BE NON-LINEAR BUT SHOULD BE WELL BEHAVED BECAUSE OF THE FINITE STEP SIZE USED IN INTEGRATION

EXAMPLE

DX1/DT=-X1+X2×X2 +COS T
DX2/DT=-X1×SIN T +X2÷1-3 ×COS T
TO SET COEFFICIENTS, TYPE

```
∇SET [2]
A←(2,2)⍴¯1,(X[2;1]),(¯1×SIN T),1
D←(2,2)⍴1,0,¯3,1
M←(2,1)⍴COS T
N←(2,1)⍴0
∇              (DON'T FORGET THE CLOSING ∇)
```

ONCE COEFFICIENTS ARE SET, TYPE

```
T GILL X
```

TO STOP BEFORE TABULATION IS COMPLETE PRESS ATTN THEN TYPE

```
→0
```

LIB 34 MATRIX
J. GREEN; E.E.DEPT.; U. OF ALBERTA

THIS WORKSPACE PERFORMS REAL AND COMPLEX MATRIX ALGEBRA AND SOLVES LINEAR EQUATIONS. IT IS INTENDED TO RUN IN CONJUNCTION WITH WORKSPACE 32 COMPLEX.

THE FOLLOWING FUNCTIONS EXIST IN MATRIX:

NAME	SYNTAX	COMMENTS
DET	B←DET X	THE DETERMINANT OF X (SCALAR) SPECIFIES B FOR ANY LEGAL REAL SQUARE MATRIX X
CDET	C←CDET Z	THE COMPLEX DETERMINANT OF Z (COMPLEX SCALAR) SPECIFIES C FOR ANY LEGAL COMPLEX SQUARE MATRIX
INV	B←INV X	THE INVERSE MATRIX OF X SPECIFIES B (A REAL SQUARE MATRIX) FOR X ANY REAL LEGAL SQUARE MATRIX WITH A NON-ZERO DETERMINANT
CINV	C←CINV Z	THE COMPLEX INVERSE MATRIX OF Z SPECIFIES C FOR Z ANY COMPLEX LEGAL SQUARE MATRIX WITH A NON-ZERO DETERMINANT THE FUNCTION WILL PRESENTLY NOT RETURN A VALUE FOR THE SPECIAL CASE WHERE THE DETERMINANT OF THE REAL PART OF Z IS ZERO, AND THE DETERMINANT OF THE IMAGINARY PART IS ZERO, BUT THE COMPLEX DETERMINANT IS NON-ZERO.
CMXMUL	R←X CMXMUL Y	THE MATRIX PRODUCT OF COMPLEX MATRICIES X AND Y IN STANDARD COMPLEX NOTATION. SEE COMPLEX.
RLIN	X←B RLIN A	LINEAR EQUATION SOLVER FOR EQUATIONS WITH REAL ARGUMENTS. A IS AN (M,M) MATRIX AND B IS AN (M,N) MATRIX. X IS AN (M,N) SOLUTION MATRIX FOR AX=B. RLIN DIFFERS FROM GLIN IN THAT ROW POSITIONING IS USED IN ORDER THAT THE PIVOTS ARE THE LARGEST VALUES IN THEIR RESPECTIVE COLUMNS: HENCE GLIN IS FASTER BUT IS MORE LIKELY TO HANG UP ALSO RLIN HANDLES N SOLUTIONS AT ONCE.
CLIN	Z←B CLIN A	LINEAR EQUATION SOLVER FOR EQUATIONS WITH COMPLEX COEFFICIENTS. CLIN IS THE COMPLEX EQUIVALENT OF RLIN AND PUTS COMPLEX MATRICES IN A FORM WHICH CAN BE HANDLED BY RLIN, CALLS ON RLIN, THEN PUTS THE SOLUTION INTO NORMAL COMPLEX FORM. THE CALL IS: B CLIN A. A IS A (2 M M) ARRAY B IS A (2 M N) ARRAY BOTH THE REAL AND IMAGINARY PARTS OF A MAY BE SINGULAR SIMULTANEOUSLY.

LIB 34 MULTVAR1
X.V.WILSON, COMPUTING SCIENCE, UNIVERSITY OF ALBERTA

THIS WORKSPACE CONTAINS FUNCTIONS TO COMPUTE THE INVERSE OF A MATRIX,THE DETERMINANT, EIGENVALUES AND EIGENVECTORS, VARIMAX TRANSFORMATION MATRIX.

FUNCTION	PURPOSE
CHDI:	REPLACES THE DAGONAL ELEMENTS OF A MATRIX WITH THOSE OF A VECTOR.
INV:	COMPUTES THE INVERSE OF A MATRIX.
VDET:	COMPUTES THE VALUE OF A DETERMINANT.
PRINFAC:	COMPUTES EIGENVALUES AND PRINCIPAL FACTORS USING HOTELLING'S METHOD.
TLR:	CONSTRUCTS A SYMMETRIC MATRIX FROM VECTOR OF LOWER-LEFT HALF.
VARIMAX:	COMPUTES VARIMAX TRANSFORMATION MATRIX AND PERFORMS ROTATION.
IMAGE:	COMPUTES IMAGE FACTOR ANALYSIS. SUSPECT: USE WITH CARE.
JACFAC:	COMPUTES EIGENVALUES AND EIGENVECTORS USING JACOBI METHOD. SUSPECT: USE WITH CARE.

FUNCTIONS LABELLED SUSPECT APPEAR TO WORK BUT HAVE PRODUCED NUMERICALLY INACCURATE RESULTS FOR AT LEAST ONE TEST CASE FOR REASONS THAT ARE NOT YET CLEAR. PLEASE REPORT YOUR EXPERIENCES WITH THEM TO K.V.WILSON, EXT. 4766.

THE FUNCTION: MD← M CHDI N WILL FORM THE MATRIX MD WHOSE OFF-DIAGONAL ELEMENTS EQUAL THOSE OF M AND WHOSE DIAGONAL ELEMENTS ARE THOSE OF THE VECTOR N.

THE FUNCTION R←INV M COMPUTES R, THE INVERSE OF A SQUARE MATRIX M IF M IS NON-SINGULAR. OTHERWISE, R IS ONE.

THE FUNCTION VDET EVALUATES A DETERMINANT BY CALCULATING THE PRODUCT OF ITS EIGENVALUES AND WILL PRINT APPROPRIATE MESSAGES IF THE MATRIX IS NOT SQUARE, OR IF THE PRODUCT IS NEGATIVE. IT USED THE FUNCTIONS BAIRSTOW, EIGVAL, FRAME, QZEROS, SYNDIV, AND ZSRT. THE CONVERGENCE CRITERION IS SET AT .01 IN VDET AND MAXIT IS SET AT 50. BOTH MAY BE CHANGED.

THE FUNCTION PRINFAC R WILL CARRY OUT A PRINCIPAL FACTOR ANALYSIS OF THE MATRIX R USING HOTELLING'S METHOD. ONLY FACTORS CORRESPONDING TO EIGENVALUES OF ONE OR MORE ARE DISPLAYED ALONG WITH THE COMMUNALITIES OF THOSE FACTORS AND ALL OF THE EIGENVALUES. THE MATRIX OF EIGENVECTORS IS STORED AS E, THE VECTOR OF EIGENVALUES IS STORED AS EV AND THE DIAGONAL MATRIX OF SQUARE ROOTS OF EIGENVALUES IS STORED AS LSR SO ADDITIONAL COLUMNS OF THE FACTOR SOLUTION CAN BE EASILY OBTAINED. THIS FUNCTION USES

THE FUNCTION HFAC (HOTELLING'S METHOD) TO SOLVE FOR EIGENVALUES AND EIGENVECTORS.

THE FUNCTION M←N TLR X WILL FORM AN N×N MATRIX M FROM THE VECTOR X WHICH CONTAINS THE LOWER LEFT HALF OF A SYMMETRIC N×N MATRIX ENTERED BY ROWS AND CONTAINING OFF-DIAGONAL ELEMENTS ONLY (STARTING WITH THE 2'ND ROW). M WILL BE IDENTICAL WITH THE ORIGINAL SYMMETRIC MATRIX WITH THE POSSIBLE EXCEPTION OF HAVING 1'S IN THE DIAGONAL. OTHER DIAGONAL ELEMENTS CAN BE INSERTED USING THE CHDI FUNCTION.

THE FUNCTION VARIMAX A CARRIES OUT A VARIMAX ROTATION OF THE FACTOR MATRIX A. AFTER EXECUTION THE TRANSFORMATION MATRIX WILL BE SPECIFIED AS T. THIS FUNCTION USES THE FUNCTION ATAN IN EXECUTION.

THE FUNCTION IMAGE R WILL COMPUTE AN IMAGE FACTOR ANALYSIS OF THE MATRIX R. IT USES THE FUNCTION INV TO COMPUTE R*¯1 AND THE FUNCTION HFAC (HOTELLING'S METHOD) TO COMPUTE EIGENVALUES AND VECTORS. MOST LIKELY, THIS FUNCTION IS SUSPECT BECAUSE HFAC MAY NOT BE SUITABLE FOR MATRICES RESCALED AS IN IMAGE ANALYSIS.

UNLIKE THE OTHER FUNCTIONS , THIS PRODUCES NO OUTPUT BUT SOLVES FOR EIGENVALUES (SPECIFIED AS THE VECTOR EV AND ARRANGED IN ORDER OF DECREASING SIZE) AND THE MATRIX OF CORRESPONDING EIGENVECTORS (SPECIFIED AS THE MATRIX E) USING THE FUNCTION JACOBI (JACOBI'S METHOD) . IT WILL STOP AFTER A MAXIMUM OF 50 ITERATIONS AND REQUEST ANOTHER MAXIMUM. THE TOLERANCE PARAMETER FOR CONVERGENCE IS SET AT .01 IN LINE [2] OF JACFAC AND CAN BE ALTERED BY CHANGING THAT LINE.

THIS FUNCTION CAN BE SUBSTITUTED FOR HFAC IN PRINFAC BY CHANGING LINE [1] OF PRINFAC TO READ -- [1] JACFAC R -- AND A SIMILAR CHANGE CAN BE MADE IN IMAGE BY SO CHANGING LINE [6] OF THAT FUNCTION.

THIS FUNCTION IS PROBABLY SUSPECT BECAUSE OF A DEFECT IN THE FUNCTION JACOBI.

BODE	900.1
STRUCTUR	900.3

LIB 900 BODE
E. M. EDWARDS; E.E.DEPT; U.OF A.

THE FUNCTIONS BODE AND BODEPLOT CONTAINED IN THIS WORKSPACE PRODUCE A BODE PLOT (SYSTEM MAGNITUDE AND PHASE RESPONSE VS. FREQUENCY).

SYNTAX:

```
F BODE H
BODEPLOT
```

WHERE F AND H ARE FREQUENCY RANGE AND TRANSFER FUNCTION(S) AS DESCRIBED BELOW.

F BODE H, GIVEN A SET OF TRANSFER FUNCTIONS, H, (TO BE EXPLAINED BELOW) AND A FREQUENCY RANGE, F, COMPUTES AND STORES(IN THE GLOBAL VARIABLE BODEDATA) THE MAGNITUDE AND PHASE RESPONSE OF THE SYSTEM(S) DESCRIBED BY H FOR 21 LOGARITHMICALLY SPACED FREQUENCIES BETWEEN THE MINIMUM AND MAXIMUM VALUES OF THE VECTOR, F.

BODEPLOT PLOTS THE DATA CONTAINED IN BODEDATA AS TWO GRAPHS SEPARATED BY A LEGEND.

THE TRANSFER FUNCTION SET, H, IS FORMED AS A SINGLE OR MULTI-LAYERED MATRIX, EACH LAYER OF WHICH IS 2-ROWED REPRESENTING NUMERATOR AND DENOMINATOR OF A RATIONAL TRANSFER FUNCTION. THE COLUMNS REPRESENT THE POWERS OF S IN DECENDING ORDER. FOR EXAMPLE,

$$H = \frac{S + 1}{2(S*2) + 3S + 4}$$

IS REPPRESENTED BY `H←2 3⍴0 1 1 2 3 4`

SEVERAL BODE PLOTS MAY BE SUPERIMPOSED ON ONE SHEET BY USING A MULTI-LAYERED MATRIX FOR H. EACH LAYER IS TAKEN AS A TRANSFER FUNCTION AS DESCRIBED ABOVE. E.G. TO DETERMINE THE EFFECT OF VARYING THE 3 IN THE DENOMINATOR OF THE ABOVE EXAMPLE BETWEEN 2 AND 4 IN STEPS OF .5, THE TRANSFER FUNCTION IS SET UP AS FOLLOWS:

```
H←5 2 3⍴0 1 1 2 0 4

H[;2;2]←2 2.5 3 3.5 4
```

F MUST BE A VECTOR OF POSITIVE NUMBERS OF WHICH ONLY THE MAXIMUM AND MINIMUM ARE USED.

⍴BODEDATA IS 2,M,21, WHERE M IS ONE GREATER THAN THE NUMBER

OF SUPERIMPOSED PLOTS. THE FIRST LAYER IS THE MAGNITUDE VS. FREQUENCY DATA AND THE SECOND LAYER IS THE PHASE VS. FREQUENCY DATA PRESENTED IN STANDARD TWO-DIMENSIONAL 'GRAPH' FORMAT.

BODETITLES IS A CHARACTER STRING USED AS AN ARGUMENT FOR THE FUNCTION TITLESET TO SET UP TITLES FOR THE PLOT.
TITLESET CONVERTS A MULTILINE HOLLERITH VECTOR INTO THE TITLES SENSED BY GRAPH. AFTER EXECUTION OF:

TITLESET X

TITLE = THE FIRST TWO LINES OF X
ATITLE = THE THIRD LINE OF X
QTITLE = THE FOURTH LINE OF X
LEGEND = ALL SUBSEQUENT LINES OF X

LINES 3 AND 4 OF BODETITLES ARE IGNORED AS ATITLE AND QTITLE ARE SET APPROPRIATELY BY BODEPLOT.

OPTIONS ARE AVAILABLE TO COPE WITH SPECIAL CIRCUMSTANCES.

IF IT IS DESIRED TO RESTRICT THE RANGE OF THE GRAPH, THE GLOBALS MCLIP (FOR MAGNITUDE) AND PCLIP (FOR PHASE) MAY BE SET TO THE DESIRED RANGE. SEE CLIP UNDER GRAPHHOW.

THE TWO ELEMENT LOGICAL VECTOR BODE∆SW CONTROLS FORMAT. IT IS NORMALLY 1 1. TO USE RADIANS/SEC. RATHER THAN HERTZ, SET BODE∆SW[1]←0. TO USE 0 TO 360 DEGREES AS THE PHASE RANGE (INSTEAD OF ¯180 TO 180 DEGREES), SET BODE∆SW[2]←0.

IRRATIONAL TRANSFER FUNCTIONS MAY BE USED BY DEFINING A MONADIC FUNCTION WHICH MUST BE CALLED BODE∆FN AND USING 1 AS THE RIGHT ARGUMENT FOR BODE. BODE∆FN MUST ACCEPT A COMPLEX VECTOR OF FREQUENCIES AS ARGUMENT AND MUST RETURN THE RESPONSE(S) AS A COMPLEX VECTOR, OR A COMPLEX MATRIX WITH EACH SYSTEM REPRESENTED BY A ROW IF MORE THAN ONE SYSTEM APPEARS ON A PLOT.
SEE 32 COMPLEX.

LIB 900 STRUCTUR
E.M.EDWARDS, ELECTRICAL ENGR., UNIV OF ALBERTA

STRUCTURE IS A WORKSPACE FOR STRUCTURAL ANALYSIS AND DESIGN.

PRESENTLY IMPLEMENTED ARE:
DISP, MAKE, FORCES.

DISP REQUESTS ENTRY OF STATICS MATRIX, STIFFNESS MATRIX, LOAD CONDITION MATRIX. DISP RETURNS AS A RESULT THE VALUE OF DISPLACEMENTS. I.E.INV(A S AT) P.

TO TURN A VECTOR INTO A SQUARE DIAGONAL MATRIX,
ENTER:M←MAKE V
WHERE V IS THE VECTOR.

FORCES REQUESTS ENTRY OF STATICS MATRIX, STIFFNESS MATRIX, LOAD CONDITION MATRIX. FORCES RETURNS AS A RESULT THE VALUE OF FORCES. I.E. S AT INV(A S AT) P

LIB 910 MASS

THE PROGRAM 'MASSPEC' TAKES RAW MASS SPECTRAL DATA AND COMPUTES THE INTENSITY OF EACH PEAK AS BOTH THE PERCENT OF THE BASE PEAK AND AS PERCENT OF THE SUM OF ALL THE RELATIVE INTENSITIES (INPUT INTENSITIES) AND LISTS THEM IN ORDER OF DESCENDING ORDER OF MASS (M/E RATIO).

TO USE THIS PROGRAM:

[1] INPUT DATA TO THE VARIABLE 'DATA' AS A VECTOR OF ORDERED PAIRS, IN M/E INTENSITY ORDER.
[2] INPUT TO THE VARIABLE 'TITLE' IS ALPHANUMERIC.
[3] TYPE 'MASSPEC NUMBER' WHERE 'NUMBER' IS THE NUMBER OF M/E TO BE PRINTED IN ORDER OF DECREASING INTENSITY.

THIS PROGRAM HAS BEEN TESTED WITH UP TO EIGHTY MASSES AND EIGHTY RELATIVE INTENSITIES. THE ONLY HANG-UP ENCOUNTERED IS IF ⍴DATA IS ODD (EG. THE NUMBER OF MASS DATA POINTS DOES NOT EQUAL THE NUMBER OF INTENSITY DATA POINTS). THIS WILL ONLY HAPPEN IF THE DATA HAS BEEN INPUT INCORRECTLY. IT IS ADVISABLE TO CREATE A FUNCTION THAT CONTAINS THE DATA IN THE GLOBAL VARIABLE 'DATA' IN THIS WORKSPACE; SO THAT IN THE EVENT OF A MISSING OR INCORRECT DATA POINT THE FAULT MAY BE EASILY CORRECTED BY FUNCTION EDITING RATHER THAN BY HAVING TO TYPE ALL THE DATA IN AGAIN.

THE MASS SPECTRAL PACKAGE ('MASSPED' AND 'DFT') MAY BE COPIED BY THE USE OF THE GROUP 'MASSGP'.

LIB 910 NORM
R D MORTON, GEOLOGY DEPT, U OF ALBERTA

THE WORKSPACE NORM CONTAINS THE MAIN PROGRAM CIPWORM AND TWO RELATED PROGRAMS RND AND OXIRAT. CIPWNORM CONVERTS THE CHEMICAL COMPOSITION OF A ROCK INTO ITS 'NORMATIVE' MINERALS AS DEFINED BY CROSS, IDDINGS, PIRSSON AND WASHINGTON. FOR A DESCRIPTION OF THE C.I.P.W. CLASSIFICATION, SEE JOHANSSEN, A., 1955, 'A DESCRIPTIVE PETROGRAPHY OF THE IGNEOUS ROCKS, THE UNIV. OF CHICAGO PRESS, 2 ED., CHAPTER 8.

TO USE, SPECIFY C, A VECTOR OF PERCENTAGES OF OXIDES IN THE FOLLOWING ORDER:
SI O2, TI O2, AL2 O3, FE2 O3, FE O, MN O, MG O, CA O, NA2 O, K2 O, P2 O5, H2 O+, BA O, C O2, CR2 O3, NI O, S O2, SR O, ZR2 O, S.
THEN TYPE 'CIPWNORM'.

IF THE OXIDATION RATIO FE2 O3 / FE O + FE2 O3 IS KNOWN SOR IS SPECIFIED AS THE OXIDATION RATIO, FE2 AS THE FE O PERCENTAGE AND FE3 AS THE FE2 O3 PERCENTAGE. THEN TYPE 'OXIRAT'. THE RECALCULATED PERCENTAGES ARE THEN ENTERED IN ITEMS 4 AND 5 OF VECTOR C PRIOR TO CALLING CIPWNORM. IT SHOULD BE NOTED THAT THE VECTOR C DOES NOT REMAIN UNCHANGED AFTER CALLING CIPWNORM, AND HENCE MAY NOT BE RE-USED.

LIB 910 PROBE1
D G W SMITH, GEOLOGY DEPT., UNIV. OF ALBERTA

THE WORKSPACES PROBE1, PROBE2, PROBE3 AND PROBE4 CONTAIN THE TABLES AND PROGRAMS USED TO CORRECT RAW X-RAY INTENSITY DATA FROM AN ELECTRON MICROPROBE FOR BACKGROUND, DEAD TIME, ATOMIC NUMBER, ABSORPTION AND CHARACTERISTIC FLUORESCENCE EFFECTS.

THE PROGRAM CAN BE USED IN THE ANALYSIS OF ANY ELEMENT WITH ATOMIC NUMBER GREATER THAN TEN AT ANY INTEGRAL OPERATING VOLTAGES UP TO 35 KV AND WILL ACCOMMODATE DATA FOR THE SPECIMEN AND SEVERAL DIFFERENT STANDARDS COMPOSED OF UP TO 20 ELEMENTS. FACILITIES ARE ALSO PROVIDED FOR ADJUSTING THE COMPOSITION OF THE MATERIAL ANALYZED ON SOME BASIS SUCH AS THE STRUCTURAL FORMULA OF A MINERAL, OR PERHAPS THE ASSUMED ANION CONTENT ON THE BASIS OF THE CONCENTRATIONS OF OTHER ELEMENTS PRESENT. THIS PROGRAM WAS WRITTEN PRIMARILY TO DEAL WITH ANALYSES OF GEOLOGIC MATERIALS, BUT WILL BE APPLICABLE TO ANALYSES OF OTHER MATERIALS SUCH AS CERAMIC AND METALLURGICAL SPECIMENS, WITHOUT MODIFICATION TO THE MAIN PROGRAM OR SUBROUTINES. IT WAS DESIGNED FOR USE WITH AN ARL 'EMX' MICROPROBE, BUT WITH MINOR MODIFICATIONS CAN BE USED WITH ANY OF THE ELECTRON PROBES CURRENTLY ON THE MARKET WHICH HAVE A NORMALLY INCIDENT ELECTRON BEAM.

A FULL DESCRIPTION AND DETAILED INSTRUCTIONS FOR RUNNING THE PROGRAM WILL BE FOUND IN COMPUTER CONTRIBUTION NO. 45, 'AN APL LANGUAGE COMPUTE PROGRAM FOR USE IN ELECTRON MICROPROBE ANALYSIS' BY D G W SMITH AND M C TOMLINSON, PUBLISHED BY STATE GEOLOGICAL SURVEY, THE UNIV. OF KANSAS, 1970. A COPY OF THIS PUBLICATION IS AVAILABLE FOR REFERENCE IN THE ELECTRON MICROPROBE LAB. OF THE DEPT. OF GEOLOGY OR IN THE OFFICE OF THE APL COORDINATOR, E. ARMITAGE, ROOM 367 GENERAL SERVICES BUILDING, UNIV OF ALBERTA.

COPIES OF WORK SHEETS FOR RECORDING MICROPROBE OBSERVATIONS MAY ALSO BE OBTAINED FROM THE ELECTRON MICROPROBE LABORATORY. THE FOLLOWING VARIABLES OR VECTORS MUST BE ENTERED FROM THE WORK SHEETS PRIOR TO CALLING PROBEDATA: CC, DTC, EL, AS, B, CS, D, P, XEA, ZD, OPVO, NOL, NOB, NES, STCONC, SM, AJ, LL1(2,3,4,...), M1(2,3,4,...), N1(2,3,4,...), O1(2,3,4,...).

PAGE 12 OF THE ABOVE PUBLICATION DESCRIBES THE CONTENTS OF EACH OF THE WORKSPACES USED, AND THE SEQUENCE OF COMMANDS FOR CALLING THEM AND RUNNING PROBEDATA. PROBE1 (CALLED WS-1 IN THE ABOVE PUBLICATION) CONTAINS COEFFICIENTS FOR ALL WAVE-LENGTHS CORRESPONDING TO CODE NUMBERS 1-35 AND PROGRAM APLOADA. PROBE2 (WS-2) CONTAINS COEFFICIENTS FOR WAVELENGTHS 36-64 AND PROGRAM APLOADB WHILE PROBE3 (WS-3) CONTAINS COEFFICIENTS FOR WAVELENGTHS 65-90 AND PROGRAM APLOADC. PROBE4 (WS-4) CONTAINS THE MAIN PROGRAM PROBEDATA TOGETHER WITH VARIOUS REQUIRED SUBROUTINES, TABLES AND VARIABLES.

DUE TO CHANGES IN WORKSPACE NAMES, ETC., THE SEQUENCE OF COMMANDS ON PAGE 12 ARE NOW:

```
1    )LOAD 910 PROBE1
2    ENTER VECTOR X OF ATOMIC NUMBERS OF ALL ELEMENTS LISTED AS
     PRESENT IN THE SPECIMEN AND ALL STANDARDS (IN ANY ORDER)
3    APLOADA
         RESPONSE: 'LOADA READY'.  POSSIBLY FOLLOWED BY 'NO MORE
     MABSCO VALUES REQUIRED'.
4    )SAVE CONTINUE.  IF RESPONSE WAS 'NO MORE MABSCO VALUES
     REQUIRED' CONTINUE WITH COMMAND 13.
5    )LOAD 910 PROBE2
6    )COPY CONTINUE LOADA
7    APLOADB
         RESPONSE: AS IN COMMAND 3
8    THE SAME AS COMMAND 4
9    )LOAD 910 PROBE3
10   )COPY CONTINUE LOADA
11   APLOADC
         RESPONSE:  'LOADA READY'
12   )SAVE CONTINUE
13   )LOAD 910 PROBE4
14   )COPY CONTINUE LOADA
15   MUCO
         RESPONSE:  'MABSCO READY'
         AT THIS POINT SPECIFY ALL THE VARIABLES LISTED ON
         THE WORKSHEET.
16   PROBEDATA
     CONTINUE WITH INPUT AS SPECIFIED ON PAGES 12 TO 14.
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LIB 910 *PROBE*2

ELECTRON MICROPROBE ANALYSIS. FOR DOCUMENTATION SEE 910 *PROBE*1.

LIB 910 *PROBE*3

ELECTRON MICROPROBE ANALYSIS. FOR DOCUMENTATION SEE 910 *PROBE*1.

LIB 910 *PROBE*4

ELECTRON MICROPROBE ANALYSIS. FOR DOCUMENTATION SEE 910 *PROBE*1.

GENETICS 920.1

LIB 920 GENETICS
J.A. REDFIELD, DEPT OF ZOOLOGY, UNIV OF ALTA

THE WORKSPACE 'GENECTICS' CONTAINS FUNCTIONS WICH ARE PRIMARILY USED IN GENETICS CALCULATIONS.

THE WORKSPACE CONTAINS THE FOLLOWING FUNCTION:

HW T

HW CALCULATES FIT TO HARDY-WEINBERG EQUILIBRIUM FOR A SINGLE LOCUS WITH TWO OR THREE ALLELES. IF TWO ALLELES, A AND B, ARE PRESENT AT A LOCUS, T IS AN M×3 MATRIX WITH THE COLUMNS THE NUMBER OF AA, AB, AND BB GENOTYPES, RESPECTIVELY. IF THERE ARE THREE ALLELES, A, B, AND C, AT THE LOCUS, T IS AN M×6 MATRIX WITH THE COLUMNS BEING THE NUMBER OF AA, AB, AC, BB, BC, AND CC GENOTYPES, RESPECTIVELY. THIS FUNCTION WILL WORK WHEN M=1.
IF THREE ALLELES ARE PRESENT THE FUNCTION CONSIDERS A=C FOR CALCULATION OF FIT TO H-W EQUILIBRIUM. EXPECTATIONS ARE BASED ON LEVENE'S FORMULAE FOR SMALL SAMPLES.
IF M>1,OUTPUT WILL CONSIST OF M+1, 3×10 TABLES.
THE FIRST M TABLES ARE THE RESULTS OF APPLYING THE TEST TO EACH ROW IN T AND TABLE M+1 IS THE RESULT OF APPLYING THE TEST TO THE COLUMN SUMS OF T. IN EACH 3×10 TABLE, R[1] IS THE OBSERVED, R[2] IS THE EXPECTED, AND R[3] THE O/E; C[1] IS THE SAMPLE SIZE; C[2],C[3],C[4] ARE THE FREQUENCIES OF AA,AB,AND BB; C[5], C[6], AND C[7] ARE THE FREQUENCIES OF A, B, AND C (IF PRESENT); C[8] IS THE EFFECTIVE NUMBER OF ALLELES; C[9] IS THE OBSERVED FREQUENCIES OF HETEROZYGOTES/EXPECTED NUMBER; AND C[10] IS THE EXACT PROBABILITY OF OBTAINING THESE RESULTS BY CHANCE ALONE.

REFERENCE: CROW AND KIMURA (1970), AN INTRODUCTION TO POPULATION GENETIC THEORY. HARPER AND ROW.

GRAHAMPR	930.1
MOLVIBS	930.2
NMR	930.4
SHEBA	930.6
VIBMEMOR	930.6

LIB 930 GRAHAMPR
L.L. RINES, DEPT. OF CHEM., U. OF A.

THIS WORKSPACE CONTAINS TWO MAIN FUNCTIONS, CISBIS AND VALUE, WHICH PERFORM SIMPLE CARBONYL FORCE FIELD CALCULATIONS.

THESE FUNCTIONS WERE DEVELOPED BY R.S. GAY AS PART OF HIS PH.D. THESIS (JULY, 1970); FURTHER REFERENCE CAN BE OBTAINED FROM THE APPENDICES OF HIS THESIS OR FROM L.L. RINES.

THE FOLLOWING FUNCTIONS ARE USED IN THIS WORKSPACE:

FUNCTION	DESCRIPTION
ALPHA	α OPERATOR
AND	A COLUMN-CATENATOR (LIBRARY FUNCTION).
CISBIS	CALCULATES FORCE CONSTANTS FROM THE TWO A1, B1, AND B2 BAND POSITIONS OF AN OCTAHEDRAL TETRACARBONYL BY THE NON-LINEAR LEAST SQUARES METHOD.
CONV	SUBROUTINE FOR CISBIS
DATE	DATE WRITING (LIBRARY FUNCTION).
FFMT	FLOATING POINT FORMATER
GETIME	CLOCK READER (LIBRARY FUNCTION).
INTANGLE	SPECIFIC CARBONYL FORCE FIELD COMPUTATIONS
MINIMUM	SPECIFIC CARBONYL FORCE FIELD COMPUTATIONS
OMEGA	ω OPERATOR
PLOT	GRAPHS ONE OR MORE FUNCTIONS SIMULTANEOUSLY (LIBRARY FUNCTION).
RAMAN	CALIBRATION OF PE LR1
RES	SUBROUTINE FOR CISBIS
RESUME	RESUMPTION FUNCTION
RND	ROUNDING SUBROUTINE FOR CISBIS
SETIME	CLOCK STARTER (LIBRARY FUNCTION).
SOLVER	SOLVE SIMULTANEOUS EQUATIONS.
ULINE	UNDERLINE FUNCTION
VALUE	CALCULATES FORCE CONSTANTS FROM THE TWO A1 AND E BAND POSITIONS OF AN OCTAHEDRAL PENTACARBONYL.

LIB 930 MOLVIBS
L.L. RINES, CHEM. DEPT., U. OF A.

THIS WORKSPACE OPERATES AS AN ANALYSIS PACKAGE AND CONTAINS VARIOUS VIBRATIONAL ANALYSIS FUNCTIONS.

THESE FUNCTIONS ARE GROUPED ACCORDING TO THEIR PARTICULAR PURPOSES (INPUT, OUTPUT, SOLUTION, EDIT, SERVICE, AND LEAST SQUARES) AND CAN BE ADDED AND DELETED TO CORE SO AS TO ALLOW THE USER TO TACKLE SLIGHTLY LARGER PROBLEMS. THESE PROGRAMS WERE DEVELOPED BY R.S. GAY AS A PART OF HIS PH.D. THESIS (JULY, 1970); FURTHUR REFERENCE CAN BE OBTAINED FROM THE APPENDICES OF HIS THESIS OR FROM L.L. RINES.
THE FOLLOWING FUNCTIONS ARE USED IN THIS WORKSPACE:

FUNCTION	GROUP NAME	DESCRIPTION
ADD	EDIT	ALLOWS INPUT OF ADDITONAL FREQUENCIES.
DATE	SERVICE	WRITES DATE (LIBRARY FUNCTION).
DELAY	SERVICE	DELAYS EXECUTION (LIBRARY FUNCTION).
DESYMMETRISE	NLSQ	SUBROUTINE FOR ITERATE AND DISPLAY
DISPLAY	OUTPUT	PERFORMS THE OUTPUT.
ENTER	INPUT	ENTERS PROBLEM IDENTIFICATION.
FORMS	NLSQ	SUBROUTINE FOR ITERATE
GETIME	SERVICE	CLOCK READER (LIBRARY FUNCTION).
GETOFREQ	INPUT	ENTERS OBSERVED FREQUENCIES.
GETPHI	INPUT	ENTERS FORCE CONSTANTS.
GETU	INPUT	HANDLES NEW COORDINATES FOR ITH MOLECULE.
GETW	INPUT	ENTERS G MATRIX; ONE MOLECULE AT A TIME.
GETZ	INPUT	ENTERS PLANES OF Z 'SYMATIN' FASHION.
ITERATE	NLSQ	ADJUSTS THE FORCE CONSTANTS SET SO THAT THE FREQUENCIES ARE FITTED BY THE LEAST MEAN SQUARES METHOD.
JACOBI	SERVICE	EIGENVALUES AND EIGENVECTORS OR A REAL SYMETRIC MATRIX (LIBRARY FUNCTION).
NEWPROB	EDIT	REQUESTS THE IDENTIFICATION AND FREQ-UENCIES FOR A NEW PROBLEM, RETAINING THE OTHER DATA FROM THE PREVIOUS PROBLEM.
PARTIALS	NLSQ	SUBROUTINE FOR ITERATE
PAUSE	OUTPUT	SIGNALS COMMENCEMENT OF OUTPUT PHASE AFTER AWAITING AN ALPHAMERIC COMMENT.
RESUME	SERVICE	RESUMPTION OF INTERRUPTED CALCULATION BY →RESUME INSTRUCTION.
SCALE	NLSQ	SUBROUTINE FOR ITERATE
SECULAR	SOLU	SUBROUTINE FOR ITERATE AND SOLVE
SETIME	SERVICE	CLOCK STARTER (LIBRARY FUNCTION).
SOLVE	SOLU	CALCULATES THE VIBRATIONAL FREQUENCIES AND EIGENVECTORS FROM THE INPUT DATA.
SOLVER	SERVICE	SOLVE SIMULTANEOUS EQUATIONS (LIBRARY

		FUNCTIONS).
SYMATIN	INPUT	INPUT OF UPPER TRIANGULAR PART ONLY OF SYMMETRIC MATRICES.
ULINE	SERVICE	UNDERLINING FUNCTION FOR ALPHAMERIC COMMENTS AND LABELS.

LIB 930 NMR
A QUIRT CHEM DEPT U OF A EDMONTON ALBERTA

GIVEN CHEMICAL SHIFTS AND COUPLING CONSTANTS (DIRECT DIPOLE AS WELL AS NORMAL FERMI) THE PROGRAM CALCULATES AND PLOTS HIGH-RESOLUTION NMR SPECTRA. THE LIMIT IS SIX SPINS THOUGH FOR CONVENIENCE INPUT IS BY MAGNETICALLY EQUIVALENT GROUPS. COUPLINGS NOT MENTIONED ARE ASSUMED TO BE ZERO.

THE PROGRAM WILL REQUEST THREE KINDS OF DATA :
QUESTIONS (IDENTIFIED BY ?) ARE ANSWERED Y FOR YES OR N FOR NO.
TITLES MAY BE ANYTHING YOU CAN ENTER ON ONE LINE.
THE SYMBOL []: SHOWS THAT NUMBERS ARE WANTED.
THE EXAMPLES IN PARENTHESES BELOW ARE FOR AN A2BC MOLECULE.

NEW PROBLEM ?
THE ANSWER N PRESERVES DATA FROM THE LATEST RUN IN THIS TERMINAL SESSION SO THAT ONLY CHANGED SHIFTS AND COUPLINGS NEED BE ENTERED. NEW PROBLEM IS ASSUMED WHEN THE LIBRARY PROGRAM IS LOADED.

GROUP STRUCTURE ...
ENTER THE NUMBER OF NUCLEI IN EACH MAGNETICALLY EQUIVALENT GROUP ON ONE LINE IN ORDER. (2 1 1)

CHEMICAL SHIFTS ...
ENTER ON ONE LINE IN ORDER ONE CHEMICAL SHIFT IN HZ. FOR EACH GROUP ABOVE. (78 155 148.11)

NEW COUPLING CONSTANTS, CHEMICAL SHIFTS ...
THESE ARE ENTERED ONE ITEM PER LINE :
THE NUMBER 0 ALONE ON A LINE MEANS END OF DATA
THE NUMBER -1 ALONE ON A LINE STARTS YOU BACK AT GROUP STRUCTURE.
2 NUMBERS ON A LINE MEAN I SHIFT[I] (1 178)
3 NUMBERS ON A LINE MEAN I J COUPLING[I;J] (1 3 12.4) THE COUPLING CONSTANT INDICES REFER TO THE MAGNETICALLY EQUIVALENT GROUPS IN THE ORDER IN WHICH THEY WERE ENTERED. FOR ORDINARY COUPLINGS THE SMALLER INDEX MUST BE FIRST. FOR DIRECT DIPOLE COUPLINGS BETWEEN GROUPS THE LARGER INDEX IS FIRST; THE INDEX IS REPEATED FOR DIPOLE COUPLINGS WITHIN A GROUP.
(3 1 413.2) (2 2 880).

TABLE ? HISTOGRAM ?
THE ANSWER Y GIVES BOTH A TABLE AND A BAR PLOT WITH POSITIVE SHIFTS LEFT OF THE REFERENCE; YN OR NY GIVES ONE. THE NUMBER OF LINES SUMMED AND THE INTENSITY WEIGHTED MEAN FREQUENCY ARE PRINTED WITH EACH BAR. REGIONS OF OVER 75 LINES OF BLANK BASELINE ARE OMITTED. IF OUTPUT IS ENDED BY ANSWER N, THE COMMAND OUTPUT WILL RESTART IT.

REGION TITLE ...
THE WORD ALL GIVES DEFAULT VALUES (0.5 0.01005 1E50 -1E50)
FOR ALL FOUR PARAMETERS IN THE NEXT DATA ITEM.

LINEWIDTH,MIN.INTENSITY,LIMITS(UPPER,LOWER) ...
ENTER UP TO FOUR NUMBERS ON ONE LINE. EACH NUMBER REPLACES ONE DEFAULT VALUE FROM LEFT TO RIGHT. ANY GROUP OF TRANSITIONS WITHIN ONE LINEWIDTH IS COMBINED, AND THE RESULT KEPT IF IT HAS THE MINIMUM INTENSITY AND IS WITHIN THE FREQUENCY LIMITS. (0.2 0.05 165 140)

TO USE THE PROGRAM ENTER START.

LIB 930 SHEBA
G.W.STOCKTON. U OF A CHEMISTRY DEPT.

A METHOD FOR OBTAINING EQUILIBRIUM CONSTANTS ON THE BASIS OF NMR CHEMICAL SHIFTS.

THE METHOD IS APPLICABLE TO WEAK HYDROGEN BONDED COMPLEXES OF THE TYPE :

$$\text{DONOR} + \text{ACCEPTOR} \leftrightarrow \text{COMPLEX}$$
$$D + A \leftrightarrow C$$

THE EQUILIBRIUM QUOTIENT Q IS GIVEN BY :

$$Q = [C] / [D].[A]$$

WHERE [ ] INDICATES CONCENTRATION

THE EQUILIBRIUM CONCENTRATIONS [C], [D], [A] CAN'NOT BE MEASURED DIRECTLY SO AN ITERATIVE METHOD EMPLOYING THE NMR LINE POSITIONS AND THE INITIAL CONCENTRATIONS IS USED.
FOR A DETAILED ACCOUNT OF THE METHOD, PLEASE CONTACT THE AUTHOR ON EDMONTON 432-3507.

LIB 930 VIBMEMOR
L.L. RINES, DEPT. OF CHEM., U. OF A.

THIS WORKSPACE IS USED AS A STORAGE FOR THE INPUT USED BY THE WORKSPACE MOLVIBS.

THE FUNCTIONS HERE WERE DEVELOPED BY R.S. GAY AS A PART OF HIS PH.D. THESIS (JULY, 1970); FURTHUR REFERENCE CAN BE OBTAINED FROM THE APPENDICES OF THIS THESIS OR FROM L.L. RINES.
THE FOLLOWING FUNCTIONS ARE USED IN THIS WORKSPACE:

FUNCTION	DESCRIPTION
STORE	MAKES A PERMANENT RECORD OF THE INPUT IN A COMPACT FORM.
INDEX	DISPLAYS STORED INPUT DATA SETS
ASSEMBLE	REASSEMBLES STORED INPUT DATA SETS.
DELETE	ERASES DATA SETS STORED BY THE FUNCTION STORE.
DATE	WRITE DATE (LIBRARY FUNCTION).

LIB 940 DOSERESP
D.A.COOK, DEPT PHARMACOLOGY U. OF ALBERTA

THIS WS. IS DESIGNED TO FACILITATE THE CALCULATION OF DOSE-RESPONSE DATA FROM EXPERIMENTS IN PHARMACOLOGY AND RELATED FIELDS.

IT CONTAINS ONLY THE FUNCTION 'DOSE' AND A SUBROUTINE ASSOCIATED WITH IT CALLED 'SDD'. 'DOSE' ACCEPTS DATA FROM STUDIES OF TENSION DEVELOPED BY A PHARMACOLOGICAL PREPARATION, AND CALCULATES THESE AS A PERCENTAGE OF THE MAXIMUM RESPONSE BEFORE AND AFTER SOME TREATMENT. THE APPROPRIATE CURVES ARE THEN PLOTTED.
THE PROGRAMME DOSE IS INTERACTIVE AND TAKES NO ARGUMENTS.
IT REQUIRES 'SDD' AND 'PLOT'
THE USER IS FIRST REQUESTED TO ENTER THE DOSES USED.
NOTE THAT A DOSE OF 10^{-6} MUST BE ENTERED AS (10*-6), AND THUS IF A NUMBER OF DOSE RESPONSE CURVES ARE BEING EXAMINED OVER THE SAME DOSAGE RANGE, IT IS BEST TO SPECIFY THE DOSES AS A VARIABLE BEFORE YOU START. YOU ARE THEN ASKED TO ENTER THE RESPONSES AT EACH DOSE FOR THE FIRST PREPARATION AND THE INITIAL DOSE RESPONSE CURVE. FOR OBVIOUS REASONS THE NUMBER OF VALUES FOR RESPONSES MUST BE THE SAME AS THE NUMBER OF DOSES,AND IF IT IS NOT, AN ERROR REPORT WILL BE RECEIVED, TOGETHER WITH A REQUEST TO RE-ENTER THE LAST SET OF VALUES. WHEN ALL REPLICATES HAVE BEEN ENTERED, ENTER '↓0' AND THE DOSE RESPONSE DATA AFTER TREATMENT (BLOCKING AGENT, METABOLIC INHIBITOR ETC) IS ENTERED IN THE SAME WAY AS THE INITIAL RESPONSES. THE ORDER MUST BE MAINTAINED I.E. THE FIRST SET OF VALUES ENTERED INITIALLY MUST APPLY TO THE SAME INDIVIDUAL PREPARATION AS THE FIRST SET OF VALUES ENTERED WHEN THE FINAL RESPONSES ARE CALLED FOR. NOTE ALSO THAT THERE SHOULD BE AS MANY SETS OF VALUES ENTERED FOR THE FINAL RESPONSES AS WERE ENTERED INITIALLY.
WHEN THE DATA ARE ENTERED, ENTER A FURTHER '↓0' AND THE VALUES OF THE TENSION AT EACH DOSE FOR EACH PREPARATION EXPRESSED AS A PERCENTAGE OF THE MAXIMUM OBSERVED RESPONSE WILL BE DISPLAYED FOR THE INITIAL OBSERVATIONS. A THREE-ROW MATRIX WILL THE BE PRINTED; ROW 1 REPRESENTS THE MEAN PERCENTAGE, ROW 2 REPRESENTS THE STANDARD DEVIATION, AND ROW 3 REPRESENTS THE STANDARD ERROR. THE FINAL RESPONSES AND STATISTICAL DATA ARE DISPLAYED IN THE SAME MANNER.
FINALLY A DOSE-RESPONSE CURVE IS PLOTTED; 'o' IS USED FOR THE INITIAL CURVE, AND '*' FOR THE CURVE AFTER TREATMENT.

THE SUBROUTINE SDD WAS DESIGNED TO BE USED DURING THE RUNNING OF 'DOSE', BUT IT HAS MORE GENERAL APPLICATIONS.

IT TAKES A SINGLE MATRIX ARGUMENT, AND RETURNS A RESULT WHICH IS A MATRIX OF THREE ROWS AND THE SAME NUMBER OF COLUMNS AS WAS FOUND IN THE ARGUMENT. THE FIRST ROW OF THE MATRIX COMPRISES THE MEAN OF EACH COLUMN, THE SECOND IS THE STANDARD DEVIATION OF THIS, AND THE THIRD ROW IS THE STANDARD ERROR.

LIB 940 EFFLUX
D.A.COOK DEPT.PHARMACOLOGY U.OF ALBERTA

THIS WORKSPACE CONTAINS FUNCTIONS FOR THE ANALYSIS OF DATA FROM EXPERIMENTS IN WHICH THE EFFLUX OF A RADIO-ACTIVE TRACER IS EXAMINED WITH RESPECT TO TIME.

THE FUNCTIONS MAY THUS BE USED TO STUDY EXCRETION OF A RADIO-ACTIVE DRUG, TRACER RELEASE FROM AN ISOLATED PREPARATION OR ANY OTHER SITUATION IN WHICH THE DATA MAY ADEQUATELY BE DESCRIBED BY A MATHEMATICAL MODEL COMPRISING A LINEAR SUM OF EXPONENTIAL TERMS AND A CONSTANT. THE MOST IMPORTANT FUNCTION IN THIS WS. IS 'FLUX1' WHICH IS WRITTEN IN AN INTERACTIVE MANNER AND TAKES NO ARGUMENTS. ALL OTHER FUNCTIONS WITH THE EXCEPTION OF 'CORRECT' ARE SUBROUTINES ASSOCIATED WITH THE RUNNING OF 'FLUX1'
BRIEFLY DATA ARE PROCESSED TO PROVIDE ESTIMATES OF THE COMPARTMENT SIZES, RATE CONSTANTS AND THE 'BOUND'(INEXCHANGABLE) FRACTION FOR A ONE, TWO AND THREE COMPARTMENT SYSTEM. IN ADDITION DATA CONCERNING THE DESATURATION CURVE, RATE OF TRACER LOSS, EFFLUX COEFFICIENT AND COMPARTMENT SIZES CORRECTED FOR EFFLUX IN SERIES ARE ALSO AVAILABLE. THE DANIEL AND ROBINSON PARAMETERS (DANIEL AND ROBINSON, CANAD. J. PHYSIOL. PHARMACOL. 48 598-624 1970) ARE ALSO DISPLAYED. DETAILS OF THE CURVE FITTING PROCEEDURE EMPLOYED ARE DESCRIBED IN: COOK AND TAYLOR, COMPUT. BIOMED. RES. 4 1971 (IN PRESS)

IMPORTANT: TWO CIRCUMSTANCES MAY GIVE RISE TO ERROR REPORTS DURING THE RUNNING OF 'FLUX1'. THESE ARE:
A] A 'WS.FULL' MESSAGE WILL BE RECEIVED IF MORE THAN ABOUT TWENTY-FIVE EXPERIMENTAL VALUES ARE ENTERED. THIS ARISES FROM THE FACT THAT AT ONE POINT A MATRIX COMPRISING ALL POSSIBLE COMBINATIONS OF THE DATA IS SYNTHESISED, AND THE SIZE OF THIS MATRIX, WHICH INCREASES EXPONENTIALLY WITH THE NUMBER OF OBSERVATIONS, MAY PRECLUDE THE POSSIBILITY OF CALCULATING FURTHER VALUES.
B] A 'DOMAIN ERROR' MESSAGE WILL BE RECEIVED IF DATA ARE ENTERED AT LARGE VALUES OF T(TIME) IN THE PRESENCE OF A VERY FAST COMPARTMENT. THIS ARISES BECAUSE THE COUNTS EMERGING FROM SUCH A COMPARTMENT AT LARGE T MAY FALL TO LESS THAN 10⁻75.

THE FUNCTION 'CORRECT' IS DESIGNED TO CONVERT RAW DATA FROM SCINTILLATION OR GAS-FLOW COUNTING TO A FORM SUITABLE FOR INPUT INTO 'FLUX1'.
IN ADDITION WS. EFFLUX CONTAINS A NUMBER OF VECTORS COMPRISING DATA OF A SUITABLE FORM FOR TESTING 'FLUX1'.
THE INPUT REQUESTED FROM 'FLUX1' IS AS FOLLOWS:

CPM IN ASH :CPM REMAINING IN THE PREPARATION AT THE END OF THE EXPERIMENT.

DATA :VALUES FOR THE CPM IN EACH SAMPLE,ENTERED AS A VECTOR.

ELAPSED TIMES :CORRESPONDING TIMES FROM THE START OF THE EXPERIMENT,AT WHICH EACH SAMPLE WAS OBTAINED.

BOUND FRACTION :EITHER AN ESTIMATE OF THE BOUND FRACTION OR AN EMPTY VECTOR (⍳0). IF THE LATTER IS ENTERED THE BOUND FRACTION WILL BE ESTIMATED BY THREE DIFFERENT TECHNIQUES, AND THE MEAN WILL BE EMPLOYED IN FURTHER COMPUTATION.

THE SLOPES AND CORRESPONDING TIMES FOR THE LOG-LOG PLOT WILL BE PRINTED. THE DESATURATION CURVES WILL BE PEELED AND THE NUMBER OF COMPARTMENTS,DECIDED BY THE OPERATOR, WILL DETERMINE THE VALUES USED IN FURTHER PROCESSING. THE DANIEL AND ROBINSON FACTORS WILL ALSO BE DISPLAYED.

A LIST OF POSSIBLE OPTIONS WILL BE PRINTED AND THE OPERATOP SHOULD TYPE 'Y' UNDER THE DATA HE REQUIRES AND 'N' OTHERWISE. AT LEAST TWELVE CHARACTERS MUST BE ENTERED HERE, BUT IT IS NOT NECESSARY THAT THEY LIE EXACTLY UNDER THE APPROPRIATE HEADER. DETAILS OF THE OPTIONS AND THEIR CODE IN THE LIST DISPLAYED DURING EXECUTION OF THE FUNCTION ARE AS FOLLOWS:

RATE DATA :RATES OF EFFLUX AND CORRESPONDING TIMES.

RATE PLOT :LOG-RATE VS TIME

D AND L PLOT :(DICK AND LEA PLOT) RATE VS DESATURATION FOR LAST SIX POINTS

DESAT DATA :CPM IN THE PREPARATION,CPM-BD.FR. AND TIMES.

LOG DESAT DATA :AS ABOVE, CPM EXPRESSED LOGARITHMICALLY.

DESAT PLOT :TISSUE DESATURATION VS TIME

SLOPES :SLOPES OF RATE,CPM AND CPM-BOUND FRACTION PLOTS, USING ONLY THE POINTS INCLUDED IN THE LAST COMPARTMENT.

EF.CO.DATA :EFFLUX COEFFICIENT AND CORRESPONDING TIMES.

EF.CO.PLOT :EFFLUX COEFFICIENT VS TIME (FIRST TWO POINTS ARE OMITTED).

LOG-LOG PLOT :LOG-RATE VS LOG-DESATURATION

LOG-LOG DATA :SLOPE OF POINTS COMPRISING THE LAST CPMT ON THE LOG-LOG PLOT (=1?) AND COMPLETE DATA FOR SLOPES AND CORRESPONDING TIMES.

SPA DATA :REQUESTS INPUT OF SPECIFIC ACTIVITY OF THE MEDIUM AND THE WEIGHT OF THE TISSUE IN MGMS. PRINTS BOUND FRACTION AND COMPARTMENTS IN MMOLES/KG. ALSO APPLIES THE SERIES CORRECTION TO THE SLOW COMPARTMENT AND EXPRESSES THE VALUE BOTH IN CPM AND MMOLES/KG.

'CORRECT' IS AN INTERACTIVE ROUTINE DESIGNED FOR THE CORRECTION OF COUNTING DATA FOR QUENCHING AND BACKGROUND.

THE OPERATOR IS REQUESTED TO ENTER THE FOLLOWING INFORMATION:

TITLE	:A SUITABLE TITLE FOR THE PRINTOUT
CT TIME	:EITHER A SCALAR, IF A SINGLE COUNTING COUNTING TIME WAS USED THROUGHOUT, OR A VECTOR OF THE SAME LENGTH AS 'COUNTS' IF THE COUNTING TIMES WERE DIFFERENT FOR EACH VALUE. AFTER THIS VALUE HAS BEEN ENTERED, PRESS CARRIAGE RETURN AND ON THE NEXT LINE ENTER:
COUNTS	:EXPERIMENTAL VALUES FOR THE COUNTS. THESE SHOULD BE ENTERED IN PAIRS, FIRST THE LOWER CHANNEL COUNTS, AND THEN THE UPPER CHANNEL COUNTS FOR EACH SAMPLE. SINCE THIS DATA MAY BE EXTENSIVE, IT IS OFTEN AS WELL TO SPECIFY THE DATA AS A GLOBAL VARIABLE BEFORE CALLING CORRECT.
WEIGHTS	:NEXT THE WEIGHTS OF THE TISSUES ARE ENTERED. THE NUMBER OF VALUES ENTERED MUST BE THE SAME AS THAT ENTERED AS 'COUNTS'. IF THIS IS INAPPLICABLE TO THE INPUT DATA (i.e. IF THE DATA WAS OBTAINED FROM MEDIUM RATHER THAN TISSUE), THE SCALAR '1' SHOULD BE ENTERED. WHEN THE WEIGHTS HAVE BEEN PUT IN, PRESS CARRIAGE RETURN AND ENTER:
BACKGROUND	:A SCALAR REPRESENTING THE BACKGROUND RADIOACTIVITY IN DPM.

YOU MAY THEN SPACE THE PAPER, AND A TABLE COMPRISING THE INPUT DATA, CHANNELS RATIO, EFFICIENCY, OBSERVED DPM, DPM-BACKGROUND AND DPM/WT, WILL BE PRINTED.

PLEASE NOTE THE FOLLOWING:

A] ALL VARIABLES ARE LOCAL WITH THE EXCEPTION OF THE THREE VARIABLES DPM, WHICH IS THE VALUE OF THE COUNTS CORRECTED FOR COUNTING TIME AND QUENCHING, DPM1 WHICH REPRESENTS DPM CORRECTED FOR BACKGROUND RADIOACTIVITY, AND DPM2 WHICH IS DPM1÷WEIGHTS (USUALLY DPM/MG). THUS THE APPROPRIATE VARIABLE MAY BE ENTERED DIRECTLY INTO FLUX1 IF REQUIRED.

B] THIS FUNCTION REQUIRES 'INTERPOLATE', AND THE PRESENCE OF A GLOBAL VARIABLE CALLED 'CHS'. 'CHS' IS A TWO COLUMN MATRIX; THE FIRST COLUMN REPRESENTS THE CHANNELS RATIOS OBTAINED FROM QUENCHED STANDARDS, AND THE SECOND COLUMN

REPRESENTS THE CORRESPONDING EFFICIENCIES OF COUNTING. SUCH A MATRIX MAY BE CONSTRUCTED BY USE OF THE FUNCTION 'CHANNELS' .

THIS FUNCTION CONSTRUCTS A GLOBAL MATRIX CALLED 'CHS' IT TAKES NO ARGUMENTS, AND REQUESTS FIRST THE TRUE VALUES OF DPM FOR THE STANDARDS. THE LOWER CHANNEL COUNTS AND THE UPPER CHANNEL COUNTS ARE THEN REQUESTED, AND THE RESULT, WHICH IS NOT DISPLAYED IS THE REQUIRED MATRIX.

THE GLOBAL VARIABLES ASSOCIATED WITH THE GROUP CPTS∆N ARE AS FOLLOWS:

NAME	DESCRIPTION
CONSTANTSN	THE CONSTANTS USED TO CONSTRUCT THE SET OF DATA. THE VECTOR WITH THIS NAME COMPRISES THE COMPARTMENT SIZES, THE BOUND FRACTION AND THE CORRESPONDING RATE CONSTANTS.
TIMESN	ELAPSED TIMES WHICH CAN BE ENTERED DIRECTLY INTO THE FLUX PROGRAMME.
DATAN	DATA FOR THE CPM AT TIMES TIMESN. THIS REPRESENTS THE DATA WHICH ARE FINALLY SUBJECT TO THE PEELING PROCESS
DATAINPUTN	DATA SUITABLE FOR ENTRY INTO FLUX1 AT THE POINT WHERE DATA INPUT IS REQUESTED.
ASHN	THE COUNTS REMAINING IN THE ASH.

CMPTS∆2 IS A TWO COMPARTMENT SYSTEM WITH HALF TIMES OF ABOUT 70 MINS AND 3 MINS. CPTS∆3 CONTAINS DATA WITH VALUES SIMILAR TO THOSE OBTAINED WITH 22NA.

BUILD

THIS PROGRAMME IS DESIGNED TO SYNTHESISE DATA FOR Y ON THE BASIS OF THE FOLLOWING EQUATION:

$$Y=Ae^{-K1T} + Be^{-K2T} + Be^{-K3T} + D$$

THE INPUT OF VALUES OF T (TIMES) IS REQUESTED FIRST, FOLLOWED BY INPUT OF VALUES OF A,B,C,D,K1,K2 AND K3. THE PROGRAMME THEN GENERATES TWO GLOBAL VARIABLES, DATA AND DATA1. DATA COMPRISES THE VALUES OF Y AT THE DIFFERENT VALUES OF T, AND DATA1 COMPRISES THE INTERVAL DATA ((¯1↓DATA)-(1↓DATA)). THE MAIN PURPOSE OF THIS FUNCTION IS TO PROVIDE DATA OF A SUITABLE FORM FOR INPUT INTO THE PROGRAMME 'FLUX1'.
VALUES OF THE TIMES ARE STORED AS THE GLOBAL VARIABLE, T
THE PROGRAMME IS INTERACTIVE AND TAKES NO ARGUMENTS.

LIB 940 KINETICS
D.A.COOK, DEPT. PHARMACOLOGY, U. OF ALBERTA

THIS WS. HAS BEEN SET UP TO PROVIDE A RAPID METHOD OF OBTAINING THE MAXIMUM AMOUNT OF INFORMATION CONCERNING ENZYME KINETICS, AND HAS BEEN DEVISED IN CO-OPERATION WITH DR. T. WHITE AND DR. J.S. CHARNOCK OF THIS DEPT.

THE TWO MAJOR OPERATIONS FACILITATED BY THESE PROGRAMMES ARE THE DETERMINATION OF ACTIVATION ENERGY FROM VALUES OF THE RATE CONSTANT AT DIFFERENT TEMPERATURES, AND VALUES FOR VMAX AND KM GIVEN THE RATES AS A FUNCTION OF DIFFERENT SUBSTRATE CONCENTRATIONS. THE FIRST OPERATION IS CARRIED OUT BY REGRESSION ON THE ARRHENIOUS PLOT, AND THE SECOND MAY BE OBTAINED USING THE LINEWEAVER-BURK, HOFSTEE OR WOLF METHODS.

THE TWO TECHNIQUES DESCRIBED ABOVE ARE EXECUTED BY THE GROUPS ΔE AND MENTEN, EACH CONTAINING ALL THE FUNCTIONS AND VARIABLES NECESSARY.

ACTIVATION

THIS FUNCTION PROVIDES INFORMATION ABOUT ACTIVATION ENERGY USING THE ARRHENIOUS PLOT OF LOG K VS 1/T. IT TAKES NO ARGUMENTS BUT REQUIRES THE FOLLOWING SUBROUTINES: REG, AND, DFT, LSQPLOT, SD, RND. IT REQUIRES THE FOLLOWING GLOBAL VARIABLES: HOL2,HOL3,HOL4. BOTH THE FUNCTIONS AND THE VARIABLES ARE GROUPED UNDER THE NAME ΔE.

INPUT IS REQUESTED. THE FUNCTION WILL ACCEPT A NUMBER OF ESTIMATES OF THE RATE CONSTANT AT EACH TEMPERATURE, AND THE NUMBER OF ESTIMATES ENTERED MAY BE DIFFERENT AT EACH TEMPERATURE. REGRESSION IS CARRIED OUT AND THE BEST LINE FITTED. THE OUTPUT INCLUDES ALL THE INPUT DATA, TOGETHER WITH T(°K),1/T, LOG K FOR EACH VALUE ENTERED, MEAN K, MEAN LOG K, STANDARD ERROR OF LOG K, ACTIVATION ENERGY AND STANDARD ERROR, AND ACTIVATION ENERGY CALCULATED ON SIMPLE REGRESSION OF THE MEAN VALUES.
NOTE IF SINGLE VALUES ARE TO BE ENTERED WHEN THE RATE CONSTANTS ARE REQUESTED, THEY MUST BE PRECEDED BY A COMMA i.e. ',7' NOT '7'.

TWOΔE

THIS FUNCTION REQUIRES THE SUBROUTINE 'TWOLINE'. IT TAKES NO ARGUMENTS. THE USER IS REQUESTED TO ENTER VALUES OF THE TEMPERATURE IN °C AND THEN ESTIMATES OF THE VALUE OF THE RATE CONSTANT AT EACH TEMPERATURE. THE BEST TWO STRAIGHT LINES WHICH FIT THE OBSERVED POINTS ON THE ARRHENIOUS PLOT WILL BE CALCULATED, THE CORRESPONDING ACTIVATION ENERGIES WILL BE PRINTED, TOGETHER WITH THE

NUMBER OF POINTS ASSIGNED TO EACH LINE, AND THE TEMPERATURE AT WHICH THE TWO LINES INTERSECT. IT IS WORTH POINTING OUT THAT IF THE POINT OF INFLECTION REPRESENTS THE TEMPERATURE AT WHICH A NEW PROCESS BECOMES IMPORTANT, THERE ARE THEORETICAL REASONS FOR SUPPOSING THE TECHNIQUE USED TO BE IN ERROR. THUS THIS FUNCTION CAN ONLY APPLY TO THE SITUATION WHERE AT A CERTAIN TEMPERATURE ONE PROCESS IS REPLACED BY ANOTHER.

TWOLINE

THIS FUNCTION REQUIRES 'LSQPLOT'. USING A SET OF 'X' VALUES SPECIFIED BY THE LEFT ARGUMENT, AND A SET OF 'Y' VALUES SPECIFIED BY THE RIGHT ARGUMENT, THIS FUNCTION GIVES A RESULT COMPRISING A SIX ELEMENT VECTOR DESCRIBING THE BEST INTERSECTING STRAIGHT LINES WHICH FIT THE POINTS. THE FIRST ELEMENT IS THE SLOPE OF THE FIRST LINE, THE SECOND IS THE INTERCEPT OF THE FIRST LINE AND THE THIRD IS THE NUMBER OF POINTS ASSIGNED TO THE FIRST LINE. THE REMAINING THREE ELEMENTS DESCRIBE THE SECOND LINE IN THE SAME ORDER.

THIS FUNCTION WAS WRITTEN FOR DR. T WHITE OF THIS

MICHAELIS

DEPT. BUT IT OF INTEREST TO ANYONE WISHING TO OBTAIN ESTIMATES OF KM AND VMAX FOR AN ENZYME REACTION, USING DATA CONCERNING THE OBSERVED RATES AT DIFFERENT SUBSTRATE CONCENTRATIONS. 'MICHAELIS' TAKES NO ARGUMENTS, BUT REQUIRES THE FOLLOWING FUNCTIONS: AND, EFT, HF, LW, WF, SE, LSQPLOT AND FORMAT. THE GLOBAL VARIABLE ROL5 IS ALSO REQUIRED.

PRIOR TO THE RUNNING OF THIS FUNCTION IT IS NECESSARY FOR THE USER TO SPECIFY THREE GLOBAL VARIABLES. THESE ARE AS FOLLOWS:

VARIABLE NAME	CHARACTER
NA	A VECTOR COMPRISING ONE ELEMENT FOR EACH CONDITION UNDER WHICH DATA NEED TO BE PROCESSED. IN THE ORIGINAL TERMS OF THE PROGRAMME, THIS REPRESENTS CONCENTRATIONS OF SODIUM, AND THIS TERMINOLOGY IS EMPLOYED IN THE FUNCTION. IF ONLY ONE CONDITION IS BEING STUDIED, A SCALAR PRECEDED BY A COMMA SHOULD BE ENTERED. THE ACTUAL VALUES EMPLOYED ARE ONLY RELEVENT IN TERMS OF THE SECOND SET OF OPERATIONS DISCUSSED BELOW. IF THE LATTER ARE NOT REQUIRED, ANY NUMBERS MAY BE ENTERED, PROVIDED THE DIMENSIONS OF

	THE RESULTANT VECTOR ARE CORRECT AS DESCRIBED ABOVE.
S	A VECTOR COMPRISING THE SUBSTRATE CONCENTRATIONS.
NV	A SCALAR COMPRISING THE NUMBER OF REPLICATES CARRIED OUT.

THE PROGRAMME REQUESTS INPUT FOR ESTIMATES OF THE RATE UNDER EACH SUBSTRATE CONCENTRATION AND EACH SET OF CONDITIONS AS SPECIFIED BY THE NUMBER OF ELEMENTS IN THE VARIABLE 'NA'. THE FUNCTION THEN DISPLAYS THE CALCULATED KM AND VMAX TOGETHER WITH INFORMATION ABOUT THE LINE, USING THE TRANSFORMATIONS OF LINEWEAVER-BURK, HOFSTEE AND WOLFF. WHEN ALL THIS HAS BEEN DISPLAYED, THE MACHINE TYPES 'CONTINUE?' A RESPONSE (ON THE SAME LINE) OF 'NO' WILL CAUSE EXIT. A RESPONSE OF 'YES' WILL CAUSE THE MACHINE TO RE-CALCULATE THE KM AND VMAX IN WHICH THE VECTOR 'NA' IS EMPLOYED AS THE SUBSTRATE, AND THE SUBSTRATE IS USED TO DEFINE THE DIFFERENT CONDITIONS ι.ε. 'S' BECOMES 'NA'. ENTRY OF A SINGLE VALUE (PRECEDED BY A COMMA) FOR 'NA' WILL AUTOMATICALLY CAUSE EXIT AFTER THE FIRST OPERATIONS HAVE BEEN COMPLETED.

THE RATHER COMPLEX NATURE OF THE PROCESSES CARRIED OUT MAY REQUIRE FURTHER CLARIFICATION. IF SO CALL DAVID COOK AT 3877 OR TOM WHITE AT 3617.

THE THREE FUNCTIONS 'LW', 'HF', AND 'WF' PROCESS ENZYME KINETIC DATA BY THE METHODS OF LINEWEAVER-BURK, HOFSTEE AND WOLFF RESPECTIVELY. THE ARGUMENT STRUCTURE AND THE RESULT RETURNED ARE SIMILAR IN EACH CASE. EACH OF THESE FUNCTIONS REQUIRE THE SUBROUTINES 'SE' AND 'LSQPLOT'.

THE LEFT HAND ARGUMENT IS A VECTOR COMPRISING THE SUBSTRATE CONCENTRATIONS, AND THE RIGHT HAND ARGUMENT IS A MATRIX WITH THE SAME NUMER OF COLUMNS AS THE LEFT ARGUMENT HAS ELEMENTS. EACH ROW COMPRISES THE VALUES OF VELOCITY AT THE CORRESPONDING SUBSTRATE CONCENTRATION, AND IS USED TO CONSTRUCT A LINE CORRESPONDING TO THE LINEAR TRANSFORMATION OF THE MICHAELIS-MENTEN EQUATION. THE LINES ARE OBTAINED FOR EACH ROW OF THE RIGHT-HAND ARGUMENT AND THIS DATA IS USED TO OBTAIN THE MEAN AND STANDARD ERROR FOR THE INTERCEPTS AND SLOPE. THE RESULT CORRESPONDS TO KM, SE OF KM, VMAX, SE OF VMAX, SLOPE OF THE LINE, SE OF SLOPE, YINTERCEPT, SE OF YINT., X INTERCEPT, SE OF X INTERCEPT, THE VALUES OF THE X-CO-ORDINATES USED IN THE PLOT, THE SE OF THE X-CO-ORDINATES (IF APPROPRIATE), THE Y-CO-ORDINATES USED IN THE PLOT, AND THE SE OF THE Y-CO-ORDINATES (IF APPROPRIATE). THESE ROUTINES ARE IMPORTANT IN THE RUNNING OF THE PROGRAMME 'MICHAELIS' WHICH PROVIDES DATA VIA ALL THREE METHODS.

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