

Appendix 1 SAS/IML® Quick Reference

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Table A1.1
Operators

Operator	Symbol	Syntax Type	Data Type
sign reverse	-	prefix	num
addition	+	infix	both
subtraction	-	infix	num
index creation	:	infix	num
matrix multiplication	*	infix	num
elementwise multiplication	#	infix	num
direct product	@	infix	num
matrix power	**	infix	num
elementwise power	##	infix	num
division	/	infix	num
horizontal concatenation		infix	both
vertical concatenation	//	infix	both
element maximum	<>	infix	both

(continued)

Table A1.1
(continued)

Operator	Symbol	Syntax Type	Data Type
element minimum	><	infix	both
logical AND	&	infix	num
logical OR		infix	num
logical NOT	^	prefix	num
less than	<	infix	both
greater than	>	infix	both
equal to	=	infix	both
less than or equal to	<=	infix	both
greater than or equal to	>=	infix	both
not equal to	^=	infix	both
transpose	^	infix	both
subscripts		postfix	both

Table A1.2
Subscript
Reduction
Operators

Operator	Action
+	addition
#	multiplication
<>	maximum
><	minimum
<: >	index of maximum
>: <	index of minimum
:	mean (different from the MATRIX procedure)
##	sum of squares

Table A1.3
Operator
Precedence

Priority Group	Operators
I (highest)	^ ~ subscripts -(prefix) ## **
II	* # <> >< / @
III	+ -
IV	// :
V	< <= > >= = ^ =
VI	&
VII (lowest)	

Table A1.4
IML Functions
and Calls

Name	Description	Data Type
ABS	takes the absolute value	num
ALL	checks for all elements nonzero	num
ANY	checks for any nonzero element	num
APPLY	applies an IML module to arguments	
ARMACOV	computes an autocovariance sequence for an ARMA model	num
ARMALLIK	computes the log-likelihood and residuals for an ARMA model	num
ARMASIM	simulates a univariate ARMA series	num
BLOCK	forms block-diagonal matrices	num
BRANKS	computes bivariate ranks	num
BTTRAN	computes the block transpose	num
BYTE	translates numbers to ordinal characters	char
CHANGE	finds and replaces text in an array	char
CHAR	produces a character representation of a numeric matrix	num
CHOOSE	conditionally chooses and changes elements	both
CONCAT	performs elementwise string concatenation	char
CONTENTS	obtains the variables in a data set	char
CONVMOD	converts modules to character matrices	char
COVLAG	computes autocovariance estimates for a vector time series	num
CSHAPE	reshapes and repeats character values	char
CUSUM	calculates cumulative sums	num
CYEXHULL	finds a convex hull of a set of planar points	num
DATASETS	obtains the names of SAS data sets in a SAS data library	char
DELETE	deletes a data set	char
DESIGN	creates a design matrix	num
DESIGNF	creates a full-rank design matrix	num
DET	computes the determinant of a square matrix	num
DIAG	creates a diagonal matrix	num
DO	produces an arithmetic series	num
ECHOLON	reduces a matrix to row-echelon form	num

(continued)

Table A1.4
(continued)

Name	Description	Data Type
EIGEN	computes eigenvalues and eigenvectors	num
EIGVAL	computes eigenvalues	num
EIGVEC	creates eigenvectors	num
EXP	calculates the exponential	num
FFT	computes the finite Fourier transform	num
GENEIG	computes eigenvalues and eigenvectors of a generalized eigenproblem	num
GINV	computes the generalized inverse	num
GSORCH	computes the Gram-Schmidt orthonormalization	num
HALF	computes Cholesky decomposition	num
HANKEL	generates a Hankel matrix	num
HDIR	performs a horizontal direct product	num
HERMITE	reduces a matrix to Hermite normal form	num
HOMOGEN	solves homogeneous linear systems	num
I	creates an identity matrix	num
IFFT	computes the inverse finite Fourier transform	num
INSERT	inserts one matrix inside another	both
INT	truncates a value	num
INV	computes the matrix inverse	num
INVUPDT	updates a matrix inverse	num
IPF	performs an iterative proportional fit	num
J	creates a matrix of identical values	num
LCP	solves the linear complementarity problem	num
LENGTH	finds the length of character matrix elements	char
LOC	finds nonzero elements of a matrix	num
LOG	takes the natural logarithm	num
LP	solves the linear programming problem	num
MARG	evaluates margin totals in a multiway contingency table	num
MAX	finds the maximum value of a matrix	both
MIN	finds the smallest element of a matrix	both
MOD	computes the modulo (remainder)	both
NAME	lists the names of arguments	both

(continued)

Table A1.4
(continued)

Name	Description	Data Type
NCOL	finds the number of columns of a matrix	both
NLENG	finds the size of an element	both
NORMAL	generates a pseudo-random normal deviate	both
NROW	finds the number of rows of a matrix	both
NUM	produces a numeric representation of a character matrix	char
OPSCAL	rescales qualitative data to be a least-squares fit to qualitative data	num
ORPOL	generates orthogonal polynomials	num
PGRAF	produces scatterplots	num
POLYROOT	finds zeros of a real polynomial	num
PRODUCT	multiplies matrices of polynomials	num
RANK	ranks elements of a matrix	num
RANKTIE	ranks matrix elements with tie-averaging	num
RATIO	divides matrix polynomials	num
REMOVE	discards elements from a matrix	both
RENAME	renames a SAS data set	char
REPEAT	creates a new matrix of repeated values	num
ROOT	performs the Cholesky decomposition of a matrix	num
ROWCAT	concatenates rows without using blank compression	char
ROWCATC	concatenates rows using blank compression	char
SETDIF	compares elements of two matrices	both
SHAPE	reshapes and repeats values	both
SOLVE	solves a system of linear equations	num
SOUND	produces a tone	num
SPLINE	evaluates points on the spline	num
SPLINEC	evaluates points on the spline	num
SPLINEV	evaluates points on a spline	num
SQBSYM	converts a symmetric matrix to a square matrix	num
SQRT	calculates the square root	char
SSQ	calculates the sum of squares of all elements	num

(continued)

Table A1.4
(continued)

Name	Description	Data Type
STORAGE	lists names of matrices and modules in storage	char
SUBSTR	takes substrings of matrix elements	char
SUM	sums all elements	num
SVD	computes the singular value decomposition	num
SWEEP	sweeps a matrix	num
SYMSQR	converts a square matrix to a symmetric matrix	num
T	transposes a matrix	both
TOEPLITZ	generates a Toeplitz or block-Toeplitz matrix	num
TRACE	sums diagonal elements	num
TYPE	determines the type of a matrix	char
UNIFORM	generates pseudo-random uniform deviates	num
UNION	performs unions of sets	both
UNIQUE	sorts and removes duplicates	both
VALSET	performs indirect assignment	char
VALUE	assigns values by indirect reference	char
VECDIAG	creates a vector from a diagonal	num
XMULT	performs accurate multiplication	num
XSECT	intersects sets	both

Table A1.5
Scalar Functions

Function	Description
ABS	takes the absolute value
EXP	calculates the exponential
INT	truncates a value
LOG	takes the natural logarithm
MOD	computes the modulo (remainder)
NORMAL	generates a pseudo-random normal deviate
SQRT	calculates the square root
UNIFORM	generates pseudo-random uniform deviates

Table A1.6
Reduction
Functions

Function	Description
MAX	finds the maximum value of a matrix
MIN	returns the smallest element of a matrix
SSQ	calculates the sum of squares of all elements
SUM	sums all elements

Table A1.7
Matrix Inquiry
Commands and
Functions

Function	Description
ALL	checks for all elements nonzero
ANY	checks for any nonzero element
LOC	finds nonzero elements of a matrix
NCOL	finds the number of columns of a matrix
NLENG	finds the size of an element
NROW	finds the number of rows of a matrix
SHOW ALLNAMES	shows all attributes of all names with or without values
SHOW NAMES	shows attributes of all names having values
SHOW name	shows attributes of the matrix specified in name
TYPE	determines the type of a matrix

Table A1.8
Matrix Arithmetic
Operators and
Functions

Name	Description
*	performs matrix multiplication
@	takes the direct product of two matrices
**	raises a matrix to a power
CUSUM	calculates cumulative sums
HDIR	performs a horizontal direct product
TRACE	sums diagonal elements

Table A1.9
Matrix
Manipulation and
Reshaping
Operators and
Functions

Name	Description
^	transposes a matrix
[]	select submatrices
	concatenates matrices horizontally
//	concatenates matrices vertically

(continued)

Name	Description
BLOCK	forms block-diagonal matrices
BITRAN	computes the block transpose
DIAG	creates a diagonal matrix
I	creates an identity matrix
INSERT	inserts one matrix inside another
J	creates a matrix of identical values
REMOVE	discards elements from a matrix
REPEAT	creates a new matrix of repeated values
SHAPE	reshapes and repeats values
SQRSTM	converts a symmetric matrix to a square matrix
SYMSQR	converts a square matrix to a symmetric matrix
T	transposes a matrix
VECDIAG	creates a vector from a diagonal

Table A1.10
Character
Manipulation
Functions

Function	Description
BYTE	translates numbers to ordinal characters
CHANGE	finds and replaces text in an array
CHAR	produces a character representation of a numeric matrix
CHOOSE	conditionally chooses and changes elements
CONCAT	performs elementwise string concatenation
CSHAPE	reshapes and repeats character values
LENGTH	finds the length of character matrix elements
NAME	lists the names of arguments
NUM	produces a numeric representation of a character matrix
PRODUCT	multiplies matrices of polynomials
RATIO	divides matrix polynomials
ROWCAT	concatenates rows without blank compression
ROWCATC	concatenates rows with blank compression
SUBSTR	takes substrings of matrix elements

Table A1.11
Set Functions

Function	Description
SETDIF	compares elements of two matrices
UNION	performs unions of sets
UNIQUE	sorts and removes duplicates
XSECT	intersects sets

Table A1.12
Linear Algebraic
and Statistical
Functions and
Calls

Name	Description
CVEXHULL	finds a convex hull of a set of planar points
DESIGN	creates a design matrix
DESIGNF	creates a full-rank design matrix
DET	computes the determinant of a square matrix
ECHOLON	reduces a matrix to row-echelon form
EIGEN	computes eigenvalues and eigenvectors
EIGVAL	computes eigenvalues
EIGVEC	creates eigenvectors
GENEIG	computes eigenvalues and eigenvectors of a generalized eigenproblem
GINV	computes the generalized inverse
GSORTH	computes the Gram-Schmidt orthonormalization
HALF	computes Cholesky decomposition
HERMITE	reduces a matrix to Hermite normal form
HOMOGEN	solves homogeneous linear systems
INV	computes the matrix inverse
INVUPDT	updates a matrix inverse
IPF	performs an iterative proportional fit
LCP	solves the linear complementarity problem
LP	solves the linear programming problem
MARG	evaluates marginal totals in a multiway contingency table
ORPOL	generates orthogonal polynomials
POLYROOT	finds zeros of a real polynomial
PRODUCT	multiplies matrices of polynomials
RANK	ranks elements of a matrix
RANKTIE	ranks matrix elements with tie-averaging
RATIO	divides matrix polynomials

(continued)

Table A1.12
(continued)

Name	Description
ROOT	performs the Cholesky decomposition of a matrix
SOLVE	solves a system of linear equations
SVD	computes the singular value decomposition
SWEEP	sweeps a matrix
T	transposes a matrix

Table A1.13
Time Series
Functions

Function	Description
ARMACOV	computes an autocovariance sequence for an ARMA model
ARMALIK	computes the log-likelihood and residuals for an ARMA model
ARMASIM	simulates a univariate ARMA series
COVLAG	computes autocovariance estimates for a vector time series
FFT	computes the finite Fourier transform
HANKEL	generates a Hankel matrix
IFFT	computes the inverse finite Fourier transform
TOEPLITZ	generates a Toeplitz or block-Toeplitz matrix

Table A1.14
Base SAS
Functions

Functions by Type	Description
Arithmetic functions	
SGN	returns the sign of the argument or 0
Truncation functions	
CELL	returns the smallest integer \geq argument
FLOOR	returns the largest integer \leq argument
FUZZ	returns the integer if the argument is within $1E-12$
ROUND	rounds a value to the nearest roundoff unit
TRUNC	returns a truncated numeric value of a specified length
Mathematical functions	
ARCCOS	calculates the arccosine
ARCSIN	calculates the arcsine
ATAN	calculates the arctangent
COSINE	calculates the cosine
DIGAMMA	computes the derivative of the log of the GAMMA function
ERF	is the error function
ERFC	returns the complement of the ERF function

(continued)

Table A1.14
(continued)

Functions by Type	Description
Gamma functions	
GAMMA	produces the complete GAMMA function
LGAMMA	calculates the natural logarithm of the GAMMA function of a value
LOG2	calculates the logarithm to the base 2
LOG10	produces the common logarithm
SIN	calculates the sine
TAN	calculates the tangent
Trigonometric and hyperbolic functions	
COSH	calculates the hyperbolic cosine
SINH	calculates the hyperbolic sine
TANH	calculates the hyperbolic tangent
Probability functions	
PROBCHI	calculates the chi-square distribution function
PROBF	calculates the F distribution function
PROBIT	calculates the inverse normal distribution function
PROBNORM	calculates the normal distribution function
PROBT	calculates the t distribution function
POISSON	calculates the Poisson probability distribution function
PROBBETA	calculates the beta probability distribution function
PROBBNML	calculates the binomial probability distribution function
PROBGAM	calculates the gamma probability distribution function
PROBHYP	calculates the hypergeometric probability distribution function
PROBNEGB	calculates the negative binomial probability distribution function
Quantile functions	
BETAINV	calculates the inverse beta distribution function
CHINV	calculates the quantile for the chi-square distribution
FINV	calculates the quantile for the F distribution
GAMINV	calculates the inverse gamma distribution function
TINV	calculates the quantile for the t distribution
Sample statistic functions	
CSS	calculates the corrected sum of squares of all arguments
CV	calculates the coefficient of variation

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Table A1.14
(continued)

Functions by Type	Description
KURTOSIS	gives the kurtosis of all arguments
MEAN	computes the arithmetic mean (average)
N	returns the number of nonmissing arguments
NMISS	returns the number of missing values
RANGE	returns the range
SKEWNESS	gives the skewness
STD	calculates the standard deviation
STDERR	calculates the standard error of the mean
USS	calculates the uncorrected sum of squares
VAR	calculates the variance
Random number functions	
RANBIN	generates an observation from a binomial distribution
RANCAU	generates a Cauchy deviate
RANEXP	generates an exponential deviate
RANGAM	generates an observation from a gamma distribution
RANNOR	generates a normal deviate
RANPOI	generates an observation from a Poisson distribution
RANPBL	generates deviates from a tabled probability mass function
RANTRU	generates an observation from a triangular distribution
RANUNI	generates a uniform deviate
Financial functions	
COMPOUND	calculates compounded value parameters
DACCDB	calculates accumulated declining balance depreciation
DACDCBSL	calculates accumulated declining balance converting to straight-line depreciation
DACCSL	calculates accumulated straight-line depreciation
DACCSYD	calculates accumulated sum-of-years'-digits depreciation
DACCTAB	calculates accumulated depreciation from specified tables
DEPDB	calculates declining balance depreciation
DEPDBSL	calculates declining balance converting to straight-line depreciation
DEPSL	calculates straight-line depreciation
DEPSYD	calculates sum-of-years'-digits depreciation

(continued)

Table A1.14
(continued)

Functions by Type	Description
DEPTAB	calculates depreciation from specified tables
INTRR	calculates internal rate of return as a fraction
IRR	calculates internal rate of return as a percentage
Financial functions	
MORT	calculates mortgage loans
NETPV	calculates net present value as a fraction
NPV	calculates net present value with rate expressed as a percentage
SAVING	calculates future value of periodic saving
Character functions	
COLLATE	generates a string of characters in collating sequence
COMPRESS	removes characters from a character variable argument
INDEX	searches for a pattern of characters
INDEXC	finds the first occurrence of any one of a set of characters
LEFT	left-aligns a character string
RANK	returns the position of a character in the ASCII collating sequence
REVERSE	reverses characters
RIGHT	right-aligns a character string
SCAN	scans for words
TRANSLATE	changes characters
TRIM	removes trailing blanks
UPCASE	converts to uppercase
VERIFY	validates a character value
Date and time functions	
DATE	returns today's date as a SAS date value
DATEJUL	converts a Julian date to a SAS date value
DATEPART	extracts the date part of a SAS datetime value or literal
DATETIME	returns the current date and time of day
DAY	returns the day of the month from a SAS date value
DHMS	returns a SAS datetime value from date, hour, minute, and second
HMS	returns a SAS time value from hour, minute, and second
HOURL	returns the hour from a SAS datetime or time value or literal

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