Summary of Linear Algebra in *Mathematica*

NUMERIC and SYMBOLIC Matrix and Vector Data Entry

a = {{2,1,3}, {-5,2,-1}, {6,-1,4}}	This is a list of row lists.
MatrixForm[a]	Display matrix in standard form.
MatrixForm[b = {{4,3}, {1,2}}]	Define list of lists; display as matrix.
c = {{2, -1, 4, 6}, {0, 1, ENTER **5, 7}, {2, -9, 0, 3}}**	Data entry may extend over several rows.
w = {9, 1, 6}	Vector treated as tuple, row, or column.
v = {5, -2, 4}; ColumnForm[v]	Semicolon to separate multiple commands.
u = {2., -7., 9.}	Vector with approximate real number entries.
u [[2]]	Access single component of vector.
c[[{1,3}, Range[2,4]]]	Access part of a matrix.
e = a ;	Semicolon after command suppresses display.
e [[3,1]] = 7; MatrixForm[e]	Modify a single matrix element, and display.
c [[3]] = {-4, 7, 2, 0} ; c	Modify a matrix row.
t = Transpose[c]; t[[1]] = w; c = Transpose[t]	Modify matrix column.
MatrixForm[%]	Variable for last output.
Save["pracdata", a, b, c, e, u, v, w]	Save practice data to load in later session.

Special Constants, Matrices, and Functions

Infinity; **Pi**; **E**; **I**; **Sqrt[2]**

IdentityMatrix[3] // MatrixForm	Identity matrix.
Table [0, {3}, {5}] // MatrixForm	Zero matrix
Table [Random[ ], {3}, {5}] // MatrixForm	Random matrix with entries on (0,1).
d = DiagonalMatrix[v]; MatrixForm[d]	Diagonal matrix from list (vector).

System commands	For use on the *Turing* machine
math	Command on *Turing* to start *Mathematica*
? R*, ?? RowReduce	Help on commands
Save["yourfile", a, b, c]	Save current definitions of specified variables.
<<yourfile	Retrieve file of previously saved variables.
Clear [a, b, v]	Clear some current variables.
Dump ["yourdump"]	Save current state of entire system.
math -x yourdump	Start *Mathematica* with previously saved state.
Quit	Leave *Mathematica*.

NUMERIC and SYMBOLIC Matrix and Vector Operations

a + e, **a - e**, **2 w**, **k*w**, **3a + 2e**	Linear combinations.
a.c, **v.a**, **a.w**, **c.a**	Matrix products.
Inverse[b], **Inverse[e]**, **MatrixPower[b, -1]**	Matrix inverses.
MatrixPower[b, 3], **MatrixPower[b, -2] //N**	Matrix powers.
Inverse[a] . w, **LinearSolve[a, w]**	Solution to $ax = w$.
trace[x_] := Sum[x[[i,i]], {i, Length[x]}]	Define trace function.
Det[b], **trace[a]**, **Transpose[c]**	Determinant, trace, & transpose.
norm[x_] := Sqrt[x.x]	Define function for norm of vector.
v.w, **w.v**, **w.u**, **v.v**, **norm(v)**, **norm(u)**	Dot product and norm.
Dimensions[c], **Dimensions[w]**, **Length[w]**	Dimensions of matrix and vector.
t = c [[2]] ; c [[2]] = c [[3]]; c [[3]] = t	Interchange rows 2 and 3 of c.
c [[1]] = 2 c [[1]]	Double the first row of c.
c [[3]] = 2 c [[1]] + c [[3]]	Add twice first row to third row.

NUMERIC and SYMBOLIC Linear Algebra Algorithms

r = RowReduce[e]	Reduced row-echelon form, display rational.
MatrixForm[r] //N	Matrix display with numeric approximation.
NullSpace[c]	List of basis vectors for nullspace.
% // Transpose //MatrixForm	Basis for nullspace as columns of matrix.
{q, r} = QRDecomposition[N[a]]	$a = q^T r$; q orthogonal, r upper triangular.
Eigenvalues[b]	List of eigenvalues of b.
Eigenvectors[b]	List of eigenvectors of b.
MatrixForm[Transpose[%]]	Convert eigenvectors to columns of matrix.
{vals, vecs} = Eigensystem[b]	Compute both at once.
Eigenvalues[N[a]]	Numerical computation of eigenvalues.
CharacteristicPolynomial[a, t]	Polynomial in the variable t.
{p, s, q} = SingularValues[N[a]]	$a = p^T m q$; p, q have orthonormal rows. Diagonal matrix m with singular values s.
<<LinearAlgebra`Orthogonalization`	Load orthogonalization package. (back accents)
GramSchmidt[N[c]]	Orthonormal basis for rowspace of c.
Normalize[w]	Normalize vector w.
Projection[v, w]	Orthogonal projection of v onto w.