MATLAB Commands for Vectors and Matrices
MTHBD/CMPBD 423

- **Vectors**
  - \( v = [2 \ 4 \ 6] \) yields a row vector.
  - \( v = [2;4;6] \) or \( v = [2 \ 4 \ 6]' \) yields a column vector.
  - \( v(2) \) yields the second element in \( v \).
  - \( v(2:3) = \) yields elements 2 through 3 of \( v \).
  - \( v(1) = 0 \) replaces the 2 with a zero
  - \( v(4) = 0 \) appends a zero to \( v \) now: \( v = [2 \ 4 \ 6 \ 0] \)
  - \([m,n]=\text{size}(v)\) yields \( m = 1 \) and \( n = 3 \) or \( m = 3 \) and \( n = 1 \)
  - \( v = 0:0.5:2 \) yields \( v = [0 \ 0.5 \ 1 \ 1.5 \ 2] \)

- **Matrices**
  - \( A = [1 \ 2 \ 3; \ 4 \ 5 \ 6; \ 7 \ 8 \ 9] \) or \([1,2,3;4,5,6;7,8,9]\) (semicolon seperates rows)
  - \( \text{rref}(A) \) produces the reduced row echelon form of \( A \).
  - \([m,n]=\text{size}(A)\) yields \( m \) = number of rows in \( A \) and \( n \) = the number of columns in \( A \).
  - \( A(1,2) \) yields the element in row 1 and column 2 of \( A \).
  - \( A(:,2) \) yields the second column of \( A \).
  - \( A(2,:) \) yields teh second row of \( A \).
  - \( A(1:2,3:4) = \) yields rows 1 to 2 and columns 3 to 4 of \( A \).
  - \( A([1 \ 3 \ 2],[1 \ 3]) = \) yields rows 1 3 2 and columns 1 3 of \( A \).
  - \( A + B \) yields term by term addition (appropriate dimensions required)
  - \( A * B \) yields normal matrix multiplication (appropriate dimensions required)
  - \( A^2 = A * A \)
  - \( A.^2 \) squares each entry in \( A \).
  - \( A./2 \) divides each entry in \( A \) by 2.
  - \( \cos(A) \) takes the cosine of each term in \( A \).
  - \( \text{eye}(n) \) yields the \( n \times n \) identity matrix
  - \( \text{zeros}(n,m) \) yields an \( n \times m \) zero matrix
  - \( \text{ones}(n,m) \) yields an \( n \times m \) matrix of all ones.
  - \( \text{transpose}(A) \) yields the transpose of \( A \).
  - \( A' = \) conjugate transpose (or just transpose if real)
  - \( \text{inv}(A) \) yields the inverse of \( A \) if one exists.
  - \( \text{det}(A) \) yields the determinent of \( A \).
  - \( \text{eig}(A) \) yields a column vector of the eigenvalues of \( A \).
  - \( [V,D]=\text{eig}(A) \) yields \( V \) a matrix with columns equal to \( \pm \) the normalized eigenvectors of \( A \), and \( D \) is a diagonal matrix with the eigenvalues in decreasing size from upper left.
  - \( x = A\backslash b \) produces a solution to \( Ax = b \). (forward slash).
Matrix Factorizations

- \([L,U] = lu(A)\) returns and upper triangular matrix \(U\) and a (psychologically) lower triangular matrix \(L\) (ones on the diagonal) such that \(LU = A\). (\(L\) is actually a permutation of a lower triangular matrix).

- \([L,U,P] = lu(A)\) returns and upper triangular matrix \(U\) and lower triangular matrix \(L\) (ones on the diagonal) such that \(LU = PA\). So that to solve \(Ax = b\) use \(LUx = Pb\).

- \(R = chol(A)\) returns upper triangular \(R\) such that \(R*R' = A\). Restrictions: \(A\) must be positive definite and hermitian (symmetric if real). An error is returned if either of these restrictions is violated.

- \([V,D] = eig(A)\) yields \(V\) a matrix with columns equal to \(\pm\) the normalized eigenvectors of \(A\), and \(D\) is a diagonal matrix with the eigenvalues in decreasing size from upper left. Note: \(AV = VD\) or \(A = VDV^{-1}\).

Vector Norms: \(V\) is a vector.

- \(\text{norm}(V,P) = \text{sum}(abs(V))^{(1/P)}\).
- \(\text{norm}(V) = \text{norm}(V,2)\).
- \(\text{norm}(V,\infty) = \text{max}(abs(V))\).
- \(\text{norm}(V,-\infty) = \text{min}(abs(V))\).

Matrix Norms: \(X\) is a matrix.

- \(\text{norm}(X)\) is the largest singular value of \(X\), \(\text{max}(\text{svd}(X))\).
- \(\text{norm}(X,2)\) is the same as \(\text{norm}(X)\).
- \(\text{norm}(X,1)\) is the 1-norm of \(X\), the largest column sum, \(= \text{max}(\text{sum}(abs((X))))\).
- \(\text{norm}(X,\infty)\) is the infinity norm of \(X\), the largest row sum, \(= \text{max}(\text{sum}(abs((X'))))\).
- \(\text{norm}(X,'fro')\) is the Frobenius norm, \(\sqrt{\text{sum}(\text{diag}(X'*X))}\).
- \(\text{norm}(X,P)\) is available for matrix \(X\) only if \(P\) is 1, 2, \(\infty\) or 'fro'.

Condition Numbers: \(X\) is a matrix.

\(\text{cond}(X,p)\) is the condition number of a matrix \(X\) using the \(p\)-norm. Values of \(p\) can be 1, 2, \(\infty\), or 'fro'.