Basics

- \([a:s:b]\) — Vector from \(a\) to \(b\) in steps of length \(s\).
- \(\text{linspace}(a,b,n)\) — Vector of \(n\) equidistributed elements from \(a\) to \(b\).
- \(\pi, \exp(1)\) — Values of \(\pi\) and \(e\) \((3.14159\ldots, 2.71828\ldots)\).
- \(\text{clear}, \text{clear}(x)\) — Clear all variables, or only \(x\).
- \(\text{whos}, \text{who}\) — Describe or list all the defined variables.
- \(\text{double}(x)\) — Describe or list all the defined variables.

Arithmetic and logical operations

- \(+, -, *, /\) — Basic operations with numbers and matrices.
- \(\sim\) — Raise to a power: \(a^b = a^b\).
- \(*, \div, ^\) — Multiply, divide and power element by element.
- \&\& || ~ — Logical operators \(\&\& \), \(||\), \(~\).
- \(\text{all}, \text{any}\) — Verify whether all \((\text{all})\) or some \((\text{any})\) of the elements of a vector satisfy a condition: \(\text{any}(x>0)\): is any of the elements of \(x\) greater than 0?.

Vectors (and matrices)

- \(\text{linspace}(a,b,n)\) — Vector of \(n\) equidistributed numbers between \(a\) and \(b\).
- \([a:s:b]\) — Vector of numbers from \(a\) to \(b\) in steps of length \(s\).
- \(\text{length}(v)\) — Length (number of elements) of vector \(v\).
- \(\text{size}(M)\) — Size \((\text{rows} \times \text{columns})\) of \(M\).
- \(\text{zeros}(n,m)\) — Matrix full of 0s of \(n\) rows and \(m\) columns. If \(m\) is missing, square matrix of size \(n \times n\).
- \(\text{ones}(n,m)\) — Matrix full of 1s of \(n\) rows and \(m\) columns.
- \(\text{eye}(n)\) — Identity matrix of rank \(n\).
- \(\text{eye}(n,m)\) — Matrix of size \(n \times m\) such that the main diagonal is full of 1s and the other elements are 0.
- \(\text{diag}(v)\) — Square diagonal matrix with \(v\) in the diagonal.
- \(\text{rand}(n,m)\) — Random matrix of \(n\) rows and \(m\) columns. The elements are between 0 and 1.

Accessing elements of vectors (matrices)

**If \(x\) is a vector**

- \(x(r)\) — Element \(r\)-th of \(x\).
- \(x(r:s)\) — Elements from \(r\)-th to \(s\)-th of vector \(x\).
- \(x(r:end)\) — Elements from \(r\)-th to the last one of vector \(x\).
- \(x(:)\) — All the elements of \(x\).

If \(A\) is a matrix

- \(A(m,n)\) — Element \(m,n\) of \(A\).
- \(A(a:b,c:d)\) — Submatrix from row \(a\) to row \(b\) and from col. \(c\) to col. \(d\) of \(A\).
- \(A(a,:), A(:,b)\) — The whole row \(a\) or the whole column \(b\) of \(A\).
- \(\text{diag}(A)\) — Elements on the main diagonal of \(A\).

Functions and utilities

- \(\exp, \log, \log10\) — Exponential, logarithm and base 10 logarithm. So, \(\exp(x)\): exponential of every element of \(x\).

Function Definition

- \(f = @(x) \sin(x) - \exp(x) \cdot x^2\) — Defines function \(f\), of one variable, whose value for \(x\) is \(\sin(x) - e^x \cdot x^2\) (Always use \(\cdot, / \) and \(^\).)
- \(f = @(x,y,z) x \cdot y - z^2 \cdot y / x\) — Defines function \(f\) of 3 variables, whose value for \((x,y,z)\) is \(xy - z^2y/x\). (Always use \(\cdot, / \) and \(^\).

Plots

- \(\text{clf}, \text{cla}\) — Clear the graphical window (\(\text{clf}\)) or the active figure (\(\text{cla}\)).
- \(\text{hold on}, \text{hold off}\) — Turns on/off the overplotting toggle: \(\text{hold on}\) turns it on, \(\text{hold off}\) turns it off.
- \(\text{plot}(y)\) — If \(y\) is a vector, plot the sequence of values of \(y\).
- \(\text{plot}(x,y)\) — If \(x\) and \(y\) are vectors of the same length, plot the values of \(y\) against those of \(x\).
- \(\text{plot}(x,f(x))\) — If \(x\) is a vector and \(f\) a function, plot the points \((x,f(x))\).
- \(\text{subplot}(n,m,i)\) — Divide the graphic screen into \(n\) rows \(m\) columns and select the \(i\)-th one for plotting on it at the next call of \(\text{plot}\).
- \(\text{ezplot}(f(x))\) — If \(f(x)\) is a function of a variable, plot its graph.
- \(\text{ezplot}(f(x,y))\) — If \(f(x,y)\) is a function of two variables, plot the set \(f(x,y) = 0\).
- \(\text{axis}([x0, x1, y0, y1])\) — Redraw all the plots using the rectangle [\(x0, x1\)\(\times\)[\(y0, y1\)].
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\[ \text{xlim([x0 x1]), ylim([y0 y1])} \] — Redraw a plot for \( x \) between \( x_0 \) and \( x_1 \) (or for \( y \) between \( y_0 \) and \( y_1 \)).

**Symbolic Computations**

\[ \text{syms x y t} \] — Declare the variables \( x, y \) and \( t \) as symbolic.

\[ \text{f=x.^2+cos(y)} \] — Define \( f \) as the symbolic function \( x^2 + \cos(y) \) in the variables \( x, y \) contained in the expression. Previously, \text{syms x y} should have been run.

\[ \text{g=matlabFunction(f)} \] — If \( f \) is a symbolic function, define \( g \) as the equivalent anonymous (“with \( @ \)”) one.

\[ \text{solve(expr, x)} \] — If \( \text{expr} \) is a symbolic expression in the variable \( x \), solve the equation \( \text{expr} = 0 \). Returns a column vector containing a solution in each row. These can be given in floating point or as exact expression (use \text{double} for the values). Ex.: \text{syms x; solve(x.^2 - 1, x);}

\[ \text{ppval(p, x)} \] — Value of the polynomial expression \( v_n a_n + \cdots + v_1 a_1 + a_0 \) (notice that the exponents go from \( n-1 \) to 0).

\[ \text{roots(v)} \] — (Approximate) Roots of the polynomial \( v_n x^n + \cdots + v_1 x + v_0 \).

\[ \text{polyderiv(v)} \] — Derivative (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \( [(n-1)v_n, \ldots, 2v_2, v_1] \).

\[ \text{polyint(v)} \] — Integral (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \([v_1/(n-1), \ldots, v_{n-2}/2, v_{n-1}, 0] \): the constant is 0.

**Advanced matrix operations**

\[ \text{inv(M)} \] — Inverse of a square matrix \( M \) (if it exists).

\( \backslash \) — Solve a linear system: \( A \backslash b \) solves the system \( A x = b \) (approximately).

\[ \text{[A B] = lu(M)} \] — LU factorization of matrix \( M \): that is, the returned values satisfy \( AB = M \), \( A \) is lower triangular with 1 on its diagonal and \( B \) is upper triangular.

**Numerical computations**

**In the following commands, \( v \) is a vector: \( v=[v_1, \ldots, v_n] \).**

\[ \text{sum(v), prod(v)} \] — Sum and product of the elements of \( v \), \( v \).

\[ \text{mean(v), var(v)} \] — Mean and variance of the elements \( v \).

\[ \text{diff(v)} \] — Successive differences of \( v \). (notice that the exponents go from \( n-1 \) to 0).

\[ \text{polyval(v,a)} \] — Value of the polynomial expression \( v_n a_n + \cdots + v_1 a_1 + v_0 \) (notice that the exponents go from \( n-1 \) to 0).

\[ \text{roots(v)} \] — (Approximate) Roots of the polynomial \( v_n x^n + \cdots + v_1 x + v_0 \).

\[ \text{polyderiv(v)} \] — Derivative (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \( [(n-1)v_n, \ldots, 2v_2, v_1] \).

\[ \text{polyint(v)} \] — Integral (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \([v_1/(n-1), \ldots, v_{n-2}/2, v_{n-1}, 0] \): the constant is 0.

**Interpolation &c**

**In the following commands, \( u \) and \( v \) are vectors of the same length.**

\[ \text{interpl(u, v)} \] — Lagrange interpolating polynomial for the cloud of points \( (u, v) \), as a vector \([v_1, \ldots, v_n]\) (which represents as a polynomial of degree \( n-1 \)).

\[ \text{polyfit(x,y,n)} \] — Polynomial of degree \( n \) minimizing the quadratic error with respect to the cloud of points \( (u, v) \).

\[ \text{polyval}(p, x) \] — Value of the polynomial expression \( v_n a_n + \cdots + v_1 a_1 + a_0 \) (notice that the exponents go from \( n-1 \) to 0).

\[ \text{roots(v)} \] — (Approximate) Roots of the polynomial \( v_n x^n + \cdots + v_1 x + v_0 \).

\[ \text{polyderiv(v)} \] — Derivative (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \( [(n-1)v_n, \ldots, 2v_2, v_1] \).

\[ \text{polyint(v)} \] — Integral (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \([v_1/(n-1), \ldots, v_{n-2}/2, v_{n-1}, 0] \): the constant is 0.

**In the following commands, \( v \) is a vector: \( v=[v_1, \ldots, v_n] \).**

\[ \text{sum(v), prod(v)} \] — Sum and product of the elements of \( v \), \( v \).

\[ \text{mean(v), var(v)} \] — Mean and variance of the elements \( v \).

\[ \text{diff(v)} \] — Successive differences of \( v \). (notice that the exponents go from \( n-1 \) to 0).

\[ \text{polyval(v,a)} \] — Value of the polynomial expression \( v_n a_n + \cdots + v_1 a_1 + v_0 \) (notice that the exponents go from \( n-1 \) to 0).

\[ \text{roots(v)} \] — (Approximate) Roots of the polynomial \( v_n x^n + \cdots + v_1 x + v_0 \).

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\[ \text{polyint(v)} \] — Integral (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \([v_1/(n-1), \ldots, v_{n-2}/2, v_{n-1}, 0] \): the constant is 0.

**Polynomial operations**

**In the following commands, \( v \) is a vector: \( v=[v_1, \ldots, v_n] \).**

\[ \text{polyval(v,a)} \] — Value of the polynomial expression \( v_n a_n + \cdots + v_1 a_1 + v_0 \) (notice that the exponents go from \( n-1 \) to 0).

\[ \text{roots(v)} \] — (Approximate) Roots of the polynomial \( v_n x^n + \cdots + v_1 x + v_0 \).

\[ \text{polyderiv(v)} \] — Derivative (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \( [(n-1)v_n, \ldots, 2v_2, v_1] \).

\[ \text{polyint(v)} \] — Integral (as a vector representing a polynomial) of \( v_n x^n + \cdots + v_1 x + v_0 \), that is, \([v_1/(n-1), \ldots, v_{n-2}/2, v_{n-1}, 0] \): the constant is 0.