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Mathematical Notation Versus Julia Syntax

In the tables below we show how to express some mathematical notation (as in the textbook Vectors, Matrices, and Least Squares) in the computer language Julia. Be careful to never confuse mathematical notation and Julia syntax!

In the tables below we use this font to denote things you'd type in to Julia.

Vectors

Basics

concept	mathematical notation	Julia syntax
n-vector	$(x_1,\ldots,x_n)$, or in column format, $\begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix}$ or $\begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix}$.	Represented as 1-d array of length n. For example, a 3-vector can be written as `[x_1, x_2, x_3]` or `[x_1; x_2; x_3]`. If you type x in interactive mode, it will be displayed as a column.
vector entries	x_i.	`x[i]`.
vector size	n (x has n entries).	`length(x)`.

vector slice	$x_{i:j} = (x_i,\ldots,x_j)$.	x[i:j].
stacking	$(x, y)=(x_1,\ldots,x_n,y_1,\ldots,y_m)$	[x; y].
equality	$x = y$.	x==y returns true or false. (x=y assigns x to the value of y.)

list of vectors	$x_1,\ldots,x_k$.
	x_i: the ith vector.
	$(x_i)_j$: jth entry of x_i.
		# list of vectors
		list = [x_1, x_2, x_3]
		# first vector
		list[1]
		# third entry of second vector
		list[2][3]

Specific vectors

concept	mathematical notation	Julia syntax
zero vector	0_n or (more commonly) just 0.	zeros(n).
ones vector	1_n or 1.	ones(n).

unit vectors	$e_i = (0,\ldots,0,1,0,\ldots,0)$
	(ith entry is one).
		No built-in Julia syntax for unit vectors. The following code creates e_i:
		# create zero vector
		ei = zeros(n)
		# set i-th entry to 1
		ei[i] = 1

Vector operations and functions

In the table below we give the native Julia syntax, and the syntax using a simple module called MMA, which contains Julia definitions of some common functions arising in the course.

concept	mathematical notation	Julia syntax
vector addition, difference	$x + y$, $x - y$.	x + y, x - y.

scalar-vector multiplication	ax (or xa), with a a number.	a*x or x*a.
vector sum	$1^T x$.	sum(x).
scalar-vector addition	x + a1.	x .+ a or a .+ x.
inner product	$x^T y$.	dot(x, y).
vector norm	x.	norm(x).
RMS value	rms(x) = x/ √ n.	norm(x)/sqrt(length(x)). Using MMA: rms(x).
distance	dist(x, y) = x − y.	norm(x-y). Using MMA: dist(x, y).
average	$\text{avg}(x)=(x_1 + \cdots + x_n)/n$.	mean(x).

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de-mean	x − avg(x)1.	x - mean(x). Using MMA: demean(x).
standard deviation	std(x).	norm(x-mean(x))/sqrt(length(x)). Using MMA: std(x).
angle	(x, y).	acos(dot(x,y)/(norm(x)*norm(y)). Using MMA: angle(x, y).

correlation coefficient	ρ(x, y).	No built-in function for correlation coefficient. The following code computes it:
		# de-mean vectors
		xt = x-mean(x); yt = y-mean(y)
		rho = dot(xt,yt)/(norm(xt)*norm(yt)).
		Using MMA: corrcoef(x, y).

convolution	x ∗ y	conv(x,y).

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Matrices

Basics

concept	mathematical notation	Julia syntax
m × n matrix	$A = \begin{bmatrix} A_{11} & \cdots & A_{1n} \\ \vdots & \ddots & \vdots \\ A_{m1} & \cdots & A_{mn} \end{bmatrix}.$	Represented as 2-d array of size m × n. For example, a 2 × 3 matrix can be written as A = [A_11, A_12, A_13; A_21, A_22, A_23]. Typing A in interactive

		mode displays the entries of A.
matrix entries	A_{ij}.	A[i,j].
matrix dimensions	$m \times n$.	m, n = size(A). To get row or column dimensions separately: m = size(A)[1] n = size(A)[2].
submatrices	$A_{p:q,r:s} = \begin{bmatrix} A_{pr} & A_{p,r+1} & \cdots & A_{ps} \\ A_{p+1,r} & A_{p+1,r+1} & \cdots & A_{p+1,s} \\ \vdots & \vdots & & \vdots \\ A_{qr} & A_{q,r+1} & \cdots & A_{qs} \end{bmatrix}$.	A[p:q, r:s].
block matrix	$A = \begin{bmatrix} B & C \\ D & E \end{bmatrix}$.	A = [B C; D E].
equality	$A = B$.	A==B returns true or false. (A = B assigns A to the value of B.)

Specific matrices

concept	mathematical notation	Julia syntax
zero matrix	$0_{m\times n}$ or, more commonly, 0.	zeros(m,n).
identity matrix	$I_{n\times n}$ or, more commonly, I.	eye(n)

Matrix operations and functions

concept	mathematical notation	Julia syntax
matrix transpose	A^T.	A’ or transpose(A).
matrix-matrix sum, difference	$A + B$, $A - B$.	A + B, A - B.
column selection	jth column of A.	A[:,j].
row selection	jth row of A.	A[j,:].
scalar-matrix product	bA (or Ab), with b a number.	b*A or A*b.
matrix-vector product	Ax (A an $m \times n$ matrix, x an n-vector).	A*x.
matrix-matrix product	AB (A an $m \times n$ matrix, B an $n \times p$ matrix).	A*B.
matrix power	A^k (A square, k integer ≥ 1).	A^k.
matrix inverse	A^{-1} (A square, invertible).	inv(A).
matrix pseudo-inverse	$A^{\dagger}$.	pinv(A).
diagonal matrix	diag(d), with d a vector	diagm(d).

Linear equations and least squares

concept	mathematical notation	Julia syntax

solve equations	$x = A^{-1}b$ (A invertible)	x=A\b.
least squares	$x = (A^T A)^{-1}A^T b$ (A has independent columns)	x=A\b.
least-norm	$x = A^T (AA^T)^{-1}b$ (A has independent rows)	x=A\b.