List of Symbols

`Version`: November 29, 2022

1 Font notation

$a, b, c, \ldots, A, B, C, \ldots$	Scalars
$\mathbf{a}, \mathbf{b}, \mathbf{c}, \ldots$	Vectors
$\mathbf{A}, \mathbf{B}, \mathbf{C}, \ldots$	Matrices
$\boldsymbol{\mathcal{A}}, \boldsymbol{\mathcal{B}}, \boldsymbol{\mathcal{C}}, \ldots$	Tensors
$A, B, C, \ldots, \mathcal{A}, \mathcal{B}, \mathcal{C}, \ldots$	Sets

2 Usual symbols

$\boldsymbol{\nabla} f, \mathbf{g}$	Gradient vector
$\boldsymbol{\nabla}_x f, \mathbf{g}_x$	Gradient vector with respect x
$\mathbf{g}$ (or $\hat{\mathbf{g}}$ if the gradient vector is $\mathbf{g}$)	Stochastic approximation of the gradient vector
$\mathbf{w}, \boldsymbol{\theta}$	Parameters/coefficients/weights vector
$\boldsymbol{\mu}_x, \mathbf{m}_x$	Mean vector
$\hat{\boldsymbol{\mu}}_x, \hat{\mathbf{m}}_x$	Sample mean vector
$\mathbf{R}_\mathbf{x}$	Correlation matrix of $\mathbf{x}$
$R_x(\tau), r_x(\tau)$	Autocorrelation function of the sinal $x(t)$ or $x[n]$
$\delta(t)$	Delta function
$\delta[n]$	Kronecker function
$\hat{R}_x(\tau), \hat{r}_x(\tau)$	Estimate autocorrelation function of the sinal $x(t)$ or $x[n]$
$\hat{\mathbf{R}}_\mathbf{x}$	Sample correlation matrix
$\mathbf{K}_\mathbf{x}, \mathbf{C}_x$	Covariance matrix of $\mathbf{x}$
$\hat{\mathbf{K}}_\mathbf{x}, \hat{\mathbf{C}}_x$	Sample covariance matrix
$\mathbf{W}, \mathbf{D}$	Diagonal matrix
$\mathbf{P}$	Projection matrix; Permutation matrix
$\boldsymbol{\Lambda}$	Eigenvalue matrix
$\boldsymbol{\Sigma}$	Singular value matrix
$\mathbf{U}$	Upper matrix; Left singular vectors
$\mathbf{L}$	Lower matrix
$\mathbf{V}$	Right singular vectors
$\mathbf{J}$	Jordan matrix; Jacobian matrix
$\mathbf{S}$	Symmetric matrix
$\mathbf{Q}$	Orthogonal matrix
$\mathbf{I}_N$	$N \times N$-dimensional identity matrix
$\mathbf{0}_{M \times N}$	$M \times N$-dimensional null matrix
j	$\sqrt{-1}$

3 Linear Algebra operations

$\mathbf{A}^{-1}$	Inverse matrix
$\mathbf{A}^{+}, \mathbf{A}^{\dagger}$	Moore-Penrose pseudoinverse
$\mathbf{A}^{\mathsf{T}}$	Transpose
$\mathbf{A}^{*}$	Conjugate
$\mathbf{A}^{\mathsf{H}}$	Hermitian
$\|\cdot\|$	l_1 norm, 1-norm, or Manhatan norm
$\|\cdot\|, \|\cdot\|_2$	l_2 norm, 2-norm, or Euclidean norm
$\|\cdot\|_p$	l_p norm, p-norm, or Minkowski norm
$\|\cdot\|_\infty$	l_∞ norm, ∞-norm, or Chebyshev norm
$\|\cdot\|_{\mathrm{F}}$	Frobenius norm
$\|\mathbf{A}\|, \det(\mathbf{A})$	Determinant
$\mathrm{N}(\mathbf{A})$	Nullspace (or kernel)
$\mathrm{C}(\mathbf{A})$	Columnspace (or range), i.e., the space $\mathrm{span}\{\mathbf{a}_1, \mathbf{a}_2, \ldots, \mathbf{a}_n\}$, where $\mathbf{a}_i$ is the ith column vector of the matrix $\mathbf{A}$
$\mathrm{diag}(\mathbf{a}), \mathrm{diag}(\mathbf{A})$	Diagonalization: a square, diagonal matrix with entries given by the vector $\mathbf{a}$ or the elements in the diagonal of $\mathbf{A}$
$\mathrm{vec}(\mathbf{A})$	Vectorization: stacks the columns of the matrix $\mathbf{A}$ into a long column vector
$\mathrm{vec}_{\mathrm{d}}(\mathbf{A})$	Extracts the diagonal elements of a square matrix and returns them in a column vector
$\mathrm{vec}_{\mathrm{l}}(\mathbf{A})$	Extracts the elements strictly below the main diagonal of a square matrix in a column-wise manner and returns them into a column vector
$\mathrm{vec}_{\mathrm{u}}(\mathbf{A})$	Extracts the elements strictly above the main diagonal of a square matrix in a column-wise manner and returns them into a column vector
$\mathrm{vec}_{\mathrm{b}}(\mathbf{A})$	Block vectorization operator: stacks square block matrices of the input into a long block column matrix
$\mathrm{span}\{\mathbf{a}_1, \mathbf{a}_2, \ldots, \mathbf{a}_n\}$	Space spanned by the argument vectors
$\mathrm{rank}(\mathbf{A})$	Rank, that is, $\dim(\mathrm{span}\{\mathbf{a}_1, \mathbf{a}_2, \ldots, \mathbf{a}_n\}) = \dim(\mathrm{C}(\mathbf{A}))$, where $\mathbf{a}_i$ is the ith column vector of the matrix $\mathbf{A}$
$\mathrm{tr}(\mathbf{A})$	trace
$\otimes$	Kronecker product
$\circ$	Outer product
$\odot$	Hadamard (elementwise) product
$\diamond$	Khatri-Rao product
$\times_n$	n-mode product
$\langle \cdot, \cdot \rangle$	Inner product

4 Sets

$A \backslash B$	Set subtraction, i.e., the set containing the elements of A that are not in B
$A \cup B$	Set of union
$A \cap B$	Set of intersection
$a \in A$	a is element of A
$a \notin A$	a is not element of A
$\{1, 2, \dots, n\}$	Discrete set containing the integer elements $1, 2, \dots, n$
$\mathbb{R}$	Set of real numbers
$\mathbb{C}$	Set of complex numbers
$\mathbb{Z}$	Set of integer number
$\mathbb{B} = \{0, 1\}$	Boolean set (?)
$\mathbb{N}$	Set of natural numbers
$\mathbb{K} \in \{\mathbb{R}, \mathbb{C}\}$	???
$[a, b]$	Closed interval of a real set from a to b
(a, b)	Closed interval of a real set from a to b
$[a, b), (a, b]$	Half-open intervals of a real set from a to b

5 Signals and functions operations and indexing

$f : A \to B$	
$f \circ g$	Composition of the functions f and g
$*$	Convolution
$x(t)$	Continuous-time t
$x[n], x[k], x[m], x[i], \ldots$	Discrete-time $n, k, m, i, \ldots$
$x(n), x(k), x(m), x(i), \ldots$	Discrete-time $n, k, m, i, \ldots$ (it should be used only if there are no continuous-time signals in the context to avoid ambiguity)
$\tilde{x}(t)$ or $\tilde{x}[n]$	Estimate of $x(t)$ or $x[n]$; the Hilbert transform of $x(t)$ or $x[n]$
$x_I(t)$ or $x_I[n]$	Real or in-phase part of $x(t)$ or $x[n]$
$x_Q(t)$ or $x_Q[n]$	Imaginary or quadrature part of $x(t)$ or $x[n]$
$X(s)$	Laplace transform of $x(t)$
$X(f)$	Fourier transform (in linear frequency, Hz) of $x(t)$
$X(j\omega)$	Fourier transform (in angular frequency, rad/sec) of $x(t)$
$X(z)$	Z-transform of $x[n]$

6 Probability and stochastic processes

$E[\cdot]$	Statistical expectation
$E_u[\cdot]$	Statistical expectation with respect to u
$\mathrm{Var}(x)$	Variance of the random variable x
$\mathrm{erfc}(\cdot)$	Complementary error function
$P(A)$	Probability of the event or set A
$p(a)$ or $p(\mathbf{a})$	Probability density function of the random variable a or random vector $\mathbf{a}$
$p(x \mid A)$	Conditional probability density function
$a \sim P$	Random variable a with distribution P

7 General notations

$a \wedge b$	Logical AND of a and b
$a \vee b$	Logical OR of a and b
$\exists$	There exists
$\nexists$	There does not exist
$\exists!$	There exist an unique
$\forall$	For all
$\mid$	Such that
$\triangleq$	Equal by definition
∞	Infinity
$\lvert a \rvert$	Absolute value of a
log	Base-10 logarithm or decimal logarithm
ln	Natual logarithm
$\mathrm{Re}\{x\}$	Real part of x
$\mathrm{Im}\{x\}$	Imaginary part of x
$\mathcal{O}(\cdot)$	big-O notation
$\lceil \cdot \rceil$	Ceiling operation
$\lfloor \cdot \rfloor$	Floor operation
$\angle \cdot$	phase (complex argument)

8 Abbreviations

wrt.	With respect to
st.	Subject to
iff.	If and only if