Appendix A

Notation

In general, uppercase boldface letters ($\mathbf{A}$) denote matrices, lowercase boldface letters ($\mathbf{a}$) denote (column) vectors and italics (a, A) denote scalars. In some occasions, matrices are also represented with calligraphic fonts ($\mathcal{A}$).

$\mathbf{A}^T, \mathbf{A}^*, \mathbf{A}^H$	Transpose, complex conjugate and transpose conjugate of matrix $\mathbf{A}$, respectively.
$\mathbf{A}^{-1}, \mathbf{A}^{\#}$	Inverse and Moore-Penrose pseudoinverse of matrix $\mathbf{A}$, respectively.
$\mathbf{A}^{1/2}$	Positive definite Hermitian square root of matrix $\mathbf{A}$, i.e. $\mathbf{A}^{1/2}\mathbf{A}^{1/2} = \mathbf{A}$.
$\mathbf{A}(\mathbf{B})$	Matrix $\mathbf{A}$ is a function of the entries in matrix $\mathbf{B}$.
$\det(\mathbf{A})$	Determinant of matrix $\mathbf{A}$.
$\mathrm{Tr}(\mathbf{A})$	Trace of matrix $\mathbf{A}$.
$\mathrm{vec}(\mathbf{A})$	Column vector formed stacking the columns of matrix $\mathbf{A}$ on top of one another.
$\mathrm{diag}(\mathbf{a}), \mathrm{diag}(\mathbf{A})$	Following the Matlab notation, $\mathrm{diag}(\mathbf{a})$ is the $N \times N$ diagonal matrix whose entries are the N elements of the vector $\mathbf{a}$, and $\mathrm{diag}(\mathbf{A})$ is the column vector containing the N diagonal elements of matrix $\mathbf{A}$.
$\mathrm{Dg}(\mathbf{A})$	An $N \times N$ diagonal matrix whose entries are the N elements in the diagonal of matrix $\mathbf{A}$, i.e., $\mathrm{diag}\left([\mathbf{A}]_{1,1}, \ldots, [\mathbf{A}]_{N,N}\right)$ or, equivalently, $\mathrm{diag}(\mathrm{diag}(\mathbf{A}))$.
$\|\mathbf{a}\|$	Euclidean norm of $\mathbf{a}$, i.e. $\|\mathbf{a}\| = \sqrt{\mathbf{a}^H\mathbf{a}}$.
$\|\mathbf{a}\|_{\mathbf{W}}$	Weighted norm of $\mathbf{a}$, i.e. $\|\mathbf{a}\|_{\mathbf{W}} = \sqrt{\mathbf{a}^H\mathbf{W}\mathbf{a}}$ (with Hermitian positive definite $\mathbf{W}$).
$[\mathbf{A}]_{i,j}$	The entry of matrix $\mathbf{A}$ in the i-th row and the j-th column.
$[\mathbf{A}]_i$	The i-th column of matrix $\mathbf{A}$.

$[\mathbf{v}]_i$	The i-th element of vector $\mathbf{v}$.
$\mathbf{A} \otimes \mathbf{B}$	Kronecker product between $\mathbf{A}$ and $\mathbf{B}$. If $\mathbf{A}$ is $M \times N$, $$\mathbf{A} \otimes \mathbf{B} = \begin{bmatrix} [\mathbf{A}]_{1,1}\mathbf{B} & \cdots & [\mathbf{A}]_{1,N}\mathbf{B} \\ \vdots & \ddots & \vdots \\ [\mathbf{A}]_{M,1}\mathbf{B} & \cdots & [\mathbf{A}]_{M,N}\mathbf{B} \end{bmatrix}.$$
$\mathbf{A} \odot \mathbf{B}$	Elementwise (Schur-Hadamard) product between $\mathbf{A}$ and $\mathbf{B}$ (they must have the same dimensions).
$\mathbf{A} \geq \mathbf{B}$, $\mathbf{A} > \mathbf{B}$	The matrix $\mathbf{A} - \mathbf{B}$ is positive semidefinite and positive definite, respectively.
$\mathbf{I}_N$, $\mathbf{I}$	The $N \times N$ identity matrix and the identity matrix of implicit size.
$\mathbf{0}_{M\times N}$, $\mathbf{0}_M$, $\mathbf{0}$	An $M \times N$ all-zeros matrix, an M-long all-zeros vector and, an all-zeros matrix or vector of implicit size.
$\mathbf{1}_{M\times N}$, $\mathbf{1}_M$, $\mathbf{1}$	An $M \times N$ all-ones matrix, an M-long all-ones vector and, an all-ones matrix or vector of implicit size.
$\mathbf{d}_N$	The vector defined as $\mathbf{d}_N = [0, \ldots, N-1]^T$
$\mathbf{e}_i$	Vector that has unity in its i-th position and zeros elsewhere.
$\mathbb{R}^{M\times N}, \mathbb{C}^{M\times N}$	The set of $M \times N$ matrices with real and complex valued entries, respectively.
j	Imaginary unit ($j = \sqrt{-1}$).
$\mathrm{Re}\{\mathbf{A}\}, \mathrm{Im}\{\mathbf{A}\}$	The matrices containing the real and imaginary parts of the entries of $\mathbf{A}$ respectively.
$\arg\{a\}$	Angle of the complex number a, i.e., $\arg\{a\} = \arctan\left\{\frac{\mathrm{Im}(a)}{\mathrm{Re}(a)}\right\}$.
$\|a\|, \mathrm{sign}(a)$	Absolute value and sign of a real valued a.
$\lceil a \rceil$	Smallest integer bigger than or equal to a.
$\widehat{\mathbf{A}}$	Estimator or estimate of the matrix $\mathbf{A}$.
$f_{\mathbf{A}}(\mathbf{A})$	Probability density function of the random matrix $\mathbf{A}$.
$E\{\mathbf{A}\}$	Expectation of a random matrix $\mathbf{A}$.
$E_{\mathbf{B}}\{\mathbf{A}\}$	Expectation of a random matrix $\mathbf{A}$ with respect to the statistics in $\mathbf{B}$.
$\arg\min_{\mathbf{B}} f(\mathbf{B})$	Matrix $\mathbf{B}$ minimizing the scalar function $f(\mathbf{B})$
$\arg\max_{\mathbf{B}} f(\mathbf{B})$	Matrix $\mathbf{B}$ maximizing the scalar function $f(\mathbf{B})$

$\partial \mathbf{A}/\partial \mathbf{B}$ — If $\mathbf{B}$ is $M \times N$, $\frac{\partial \mathbf{A}}{\partial \mathbf{B}}$ is a matrix formed as

$$\frac{\partial \mathbf{A}}{\partial \mathbf{B}} = \begin{bmatrix} \frac{\partial \mathbf{A}}{\partial \{\mathbf{B}\}_{1,1}} & \cdots & \frac{\partial \mathbf{A}}{\partial \{\mathbf{B}\}_{1,N}} \\ \vdots & \ddots & \vdots \\ \frac{\partial \mathbf{A}}{\partial \{\mathbf{B}\}_{M,1}} & \cdots & \frac{\partial \mathbf{A}}{\partial \{\mathbf{B}\}_{M,N}} \end{bmatrix}.$$

In addition, for a given scalar b, $\partial \mathbf{A}/\partial b$ is the matrix containing the derivatives of the entries of $\mathbf{A}$ with respect to b. If b is complex, we have $\frac{\partial}{\partial b} = \frac{\partial}{\partial \operatorname{Re}\{b\}} - j\frac{\partial}{\partial \operatorname{Im}\{b\}}$, see [Bra83].

$\delta(i_1, \ldots, i_N)$ — Multidimensional Kronecker delta defined as

$$\delta(i_1, \ldots, i_N) = \begin{cases} 1 & i_1 = \ldots = i_N \\ 0 & otherwise \end{cases}.$$

$\delta(\mathbf{x})$ — Vectorial Dirac‘s delta defined as

$$\delta(\mathbf{x}) = \begin{cases} 1 & \mathbf{x} = \mathbf{0} \\ 0 & otherwise \end{cases}.$$

$\mathfrak{F}\{\cdot\}, \mathfrak{F}^{-1}\{\cdot\}$ — Direct and inverse Fourier transform for both the analog and discrete cases defined as $\mathfrak{F}\{x(t)\} = \int_{-\infty}^{\infty} x(t)e^{-j2\pi ft}dt$ and $\mathfrak{F}\{x[n]\} = \sum_{n=-\infty}^{\infty} x[n]e^{-j2\pi fn}$, respectively.

$*$ — Analog or discrete convolution defined as $x(t) * y(t) = \int_{-\infty}^{\infty} x(\tau)y(t-\tau)d\tau$ or $x[n] * y[n] = \sum_{k=-\infty}^{\infty} x[k]y[n-k]$, respectively.

$x \in (A, B]$ — The scalar x belongs to the interval given by $x > A$ and $x \leq B$

$\operatorname{sinc}(x)$ — Function defined as $\operatorname{sinc}(x) \triangleq \begin{cases} \sin(\pi x)/(\pi x) & x \neq 0 \\ 1 & x = 0 \end{cases}$.

sup — Supremum (lowest upper bound). If the set is finite, it coincides with the maximum (max).

lim sup — Limit superior (limit of the sequence of suprema).

$O(\cdot), o(\cdot)$ — Landau symbols for order of convergence.

$\triangleq$ — Symbol used to define a new variable.

$\propto$ — It stands for “proportional to” or sometimes “equivalent to”.

$\ln(\cdot)$ — Natural logarithm.