# Notes on Notation

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## I. Conventions & Symbols

Tables I-VI summarize the notational conventions that are used throughout this text. A non-bold face symbol denotes a scalar quantity. A bold face symbol denotes either a vector (typically lower case) or a matrix (typically upper case). It is important to make the distinction between a *true* value, a *calculated*, *estimated*, or a *measured* value. As shown in Table I, the true value has no additional mark; the calculated value has a "hat" on it; the measured value has a "tilde" above it. The error is defined as the true value minus the estimated value. The error quantity is indicated with a $\delta$, for example $\delta\boldsymbol{x} = \boldsymbol{x} - \hat{\boldsymbol{x}}$.

TABLE I

Notational conventions.

| | |
|---|---|
| $x$ | non-bold face variables denote *scalars* |
| $\boldsymbol{x}$ | boldface lower-case denotes *vector* quantities |
| $\mathbf{X}$ | boldface upper-case denotes *matrix* quantities |
| $x_{i,j}$ | row $i$ and column $j$ entry of matrix $\mathbf{X}$ |
| $\boldsymbol{x}$ | true value of $\boldsymbol{x}$ |
| $\hat{\boldsymbol{x}}$ | calculated value of $\boldsymbol{x}$ |
| $\tilde{\boldsymbol{x}}$ | measured value of $\boldsymbol{x}$ |
| $\delta\boldsymbol{x}$ | error $\boldsymbol{x} - \hat{\boldsymbol{x}}$ |
| $\mathbf{R}_a^b$ | transformation matrix from reference frames $a$ to $b$ |
| $\boldsymbol{x}^a$ | vector $\boldsymbol{x}$ represented with respect to frame $a$ |
| $\mathbb{R}, \mathbb{R}^+, \mathbb{R}^n$ | real numbers, reals greater than 0, $n$-tuples of reals |
| $\mathbb{N}$ | natural numbers $\{0, 1, 2, \ldots\}$ |
| $\mathbb{C}$ | complex numbers |
| $\mathbb{Z}$ | integer numbers |
| $\mathbf{0}_{n\times m}$ or $\mathbf{0}$ | zero matrix |
| $\mathbf{I}_{n\times n}$ or $\mathbf{I}$ | identity matrix |
| $\lvert\mathbf{X}\rvert$ | determinant of matrix $\mathbf{X}$ |
| $R, N$ | range space, null space |
| $R_\infty, N_\infty$ | generalized range space and null space |
| $\mathcal{N}$ | Normal or Gaussian random variable |
| $\mathcal{L}$ | Laplace random variable |
| $\blacksquare$ | end of proof, "I have proved" |

TABLE II

Equivalence symbols.

| | |
|---|---|
| $=$ | equal to |
| $\neq$ | not equal to |
| $>$ | greater than |
| $<$ | less than |
| $\geq$ | greater than or equal to |
| $\leq$ | less than or equal to |
| $\propto$ | proportional to |
| $\approx$ | approximately equal to |
| $\sim$ | distributed as (or indifference) |
| $\equiv$ | equivalent to |
| $\triangleq$ | computed as |
| $\succ$ | preferred to |

TABLE III

Set notation symbols.

| | |
|---|---|
| $(a\,..\,b), [a\,..\,b]$ | open interval, closed interval |
| $\langle \ldots \rangle$ | sequence (a list in which order matters) |
| $\{\ldots\}$ | set (a list in which order does not matter) |
| $\in$ | is an element of |
| $\varnothing$ | empty set |
| $\cup$ | union |
| $\cap$ | intersection |
| $\subset$ | subset |

TABLE IV

Logical symbols.

| | |
|---|---|
| $\therefore$ | therefore |
| $\forall$ | for all |
| $\exists$ | there exists |
| $\Longrightarrow$ | logical "then" statement |
| $\Longleftrightarrow$ | if and only if |

TABLE V

Abbreviations.

| | |
|---|---|
| $iff$ | if an only if |
| s.t. | such that |
| LHS | left hand side |
| RHS | right hand side |
| QED | end of proof, "I have proved" |
| w.r.t. | with respect to |

TABLE VI

Greek letters with pronunciation.

| | |
|---|---|
| $\alpha$ | alpha *AL-fuh* |
| $\beta$ | beta *BAY-tuh* |
| $\gamma, \Gamma$ | gamma *GAM-muh* |
| $\delta, \Delta$ | delta *DEL-tuh* |
| $\epsilon$ | epsilon *EP-suh-lon* |
| $\zeta$ | zeta *ZAY-tuh* |
| $\eta$ | eta *AY-tuh* |
| $\theta, \Theta$ | theta *THAY-tuh* |
| $\iota$ | iota *eye-OH-tuh* |
| $\kappa$ | kappa *KAP-uh* |
| $\lambda, \Lambda$ | lambda *LAM-duh* |
| $\mu$ | mu *MEW* |
| $\nu$ | nu *NEW* |
| $\xi, \Xi$ | xi *KSIGH* |
| $o$ | omicron *OM-uh-CRON* |
| $\pi, \Pi$ | pi *PIE* |
| $\rho$ | rho *ROW* |
| $\sigma, \Sigma$ | sigma *SIG-muh* |
| $\tau$ | tau *TOW (as in cow)* |
| $\upsilon, \Upsilon$ | upsilon *OOP-suh-LON* |
| $\phi, \Phi$ | phi *FEE, or FI (as in hi)* |
| $\chi$ | chi *KI (as in hi)* |
| $\psi, \Psi$ | psi *SIGH, or PSIGH* |
| $\omega, \Omega$ | omega *oh-MAY-guh* |