

# The `statmath` package\*

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## Abstract

Applied and theoretical papers in statistics usually contain a number of notational conventions which are currently lacking in the popular `amsmath` package. This package provides commands for such standard statistical-mathematical language, including bold Roman and Greek letters, convergence symbols, matrix operations.

## 1 Introduction

Applied and theoretical papers in statistics usually contain a number of notational conventions which are currently lacking in the popular `amsmath` package. The seasoned L<sup>A</sup>T<sub>E</sub>X user will see that the provided commands are simple, almost trivial, but will hopefully offer less cluttered preambles as well as a welcome help for novice users.

## 2 Usage

<code>\bfA</code>	Capital Roman letter: <b>A</b>
<code>\bfa</code>	Lower-case Roman letter: <b>a</b>
<code>\bfGamma</code>	Capital Greek letter: <b>Γ</b>
<code>\bfalpha</code>	Lower-case Greek letter: <b>α</b>
<code>\bfzero</code>	Bold zero: <b>0</b>
<code>\cov</code>	Covariance: $\text{Cov}(X, Y)$
<code>\E</code>	Expectation: $E(X)$
<code>\V</code>	Variance: $V(X)$
<code>\inas</code>	Convergence almost surely: $X_n \xrightarrow{a.s.} X$
<code>\inprob</code>	Convergence in probability: $X_n \xrightarrow{p} X$
<code>\indist</code>	Convergence in distribution: $X_n \xrightarrow{d} X$
<code>\plim</code>	Probability limit: $\text{plim } X_n = X$
<code>\tr</code>	Trace of matrix: $\text{tr}(\mathbf{A})$
<code>\vc</code>	Vectorization of matrix: $\text{vec}(\mathbf{A})$

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\*This document corresponds to `statmath` v0.2, dated 2018/03/12.

<code>\vecs</code>	Strict half-vectorization of matrix: $\text{vecs}(\mathbf{A})$
<code>\vch</code>	Half-vectorization of matrix: $\text{vech}(\mathbf{A})$
<code>\diag</code>	Diagonal of matrix: $\text{diag}(\mathbf{A})$
<code>\det</code>	Determinant of matrix: $\det(\mathbf{A})$
<code>\rank</code>	Rank of matrix: $\text{rank}(\mathbf{A})$
<code>\argmin</code>	Minimize argument: $\hat{\theta} = \arg \min_{\theta \in \Theta} f(\theta)$
<code>\argmax</code>	Maximize argument: $\hat{\theta} = \arg \max_{\theta \in \Theta} f(\theta)$

### 3 Implementation

The default is to use `\mathbf` for Roman letters and `\boldsymbol` for Greek letters. Both can be changed (individually) to `\bm`.

```

1 \RequirePackage{amsmath}
2 \RequirePackage{bbm}
3 \RequirePackage{bm}%
4
5 \DeclareOption{abcbm}{%
6   \let\abcbf\bm%
7 }
8 \DeclareOption{greekbm}{%
9   \let\greekbf\bm%
10 }
11 \DeclareOption{abcbf}{%
12   \let\abcbf\mathbf%
13 }
14 \DeclareOption{greekbs}{%
15   \let\greekbf\boldsymbol%
16 }
17
18 \ExecuteOptions{abcbf,greekbs}
19
20 \ProcessOptions\relax

```

### 3.1 Bold letters and symbols

`\bfA` Capital letters are obtained by `\bfA`, `\bfB`, etc. The command `\abcbf` is either  
`\bfB` `\textbf` or `\bm`, depending on options `abcbf` or `abcbm`.

`\bfC` 21 `\newcommand{\bfA}{\abcbf A}`  
`\bfD` 22 `\newcommand{\bfB}{\abcbf B}`  
`\bfE` 23 `\newcommand{\bfC}{\abcbf C}`  
`\bfF` 24 `\newcommand{\bfD}{\abcbf D}`  
`\bfG` 25 `\newcommand{\bfE}{\abcbf E}`  
`\bfH` 26 `\newcommand{\bfF}{\abcbf F}`  
`\bfI` 27 `\newcommand{\bfG}{\abcbf G}`  
`\bfJ` 28 `\newcommand{\bfH}{\abcbf H}`  
`\bfK` 29 `\newcommand{\bfI}{\abcbf I}`  
`\bfL` 30 `\newcommand{\bfJ}{\abcbf J}`  
`\bfL` 31 `\newcommand{\bfK}{\abcbf K}`  
`\bfM` 32 `\newcommand{\bfL}{\abcbf L}`  
`\bfN` 33 `\newcommand{\bfM}{\abcbf M}`  
`\bfO` 34 `\newcommand{\bfN}{\abcbf N}`  
`\bfP` 35 `\newcommand{\bfO}{\abcbf O}`  
`\bfQ` 36 `\newcommand{\bfP}{\abcbf P}`  
`\bfR` 37 `\newcommand{\bfQ}{\abcbf Q}`  
`\bfS` 38 `\newcommand{\bfR}{\abcbf R}`  
`\bfT` 39 `\newcommand{\bfS}{\abcbf S}`  
`\bfU` 40 `\newcommand{\bfT}{\abcbf T}`  
`\bfU` 41 `\newcommand{\bfU}{\abcbf U}`  
`\bfV` 42 `\newcommand{\bfV}{\abcbf V}`  
`\bfW` 43 `\newcommand{\bfW}{\abcbf W}`  
`\bfX` 44 `\newcommand{\bfX}{\abcbf X}`  
`\bfY` 45 `\newcommand{\bfY}{\abcbf Y}`  
`\bfZ` 46 `\newcommand{\bfZ}{\abcbf Z}`

`\bfa` Lower-case letters are obtained by `\bfa`, `\bfb`, etc. The command `\abcbf` is either `\textbf` or `\bm`, depending on options `abcbf` or `abcbm`.

```

\bfc 47 \newcommand{\bfa}{\abcbf a}
\bfd 48 \newcommand{\bfb}{\abcbf b}
\bfe 49 \newcommand{\bfc}{\abcbf c}
\bff 50 \newcommand{\bfd}{\abcbf d}
\bfg 51 \newcommand{\bfe}{\abcbf e}
\bfh 52 \newcommand{\bff}{\abcbf f}
\bfj 53 \newcommand{\bfg}{\abcbf g}
\bfk 54 \newcommand{\bfh}{\abcbf h}
\bfj 55 \newcommand{\bfj}{\abcbf i}
\bfk 56 \newcommand{\bfj}{\abcbf j}
\bfk 57 \newcommand{\bfk}{\abcbf k}
\bfm 58 \newcommand{\bfl}{\abcbf l}
\bfm 59 \newcommand{\bfm}{\abcbf m}
\bfm 60 \newcommand{\bfm}{\abcbf n}
\bfm 61 \newcommand{\bfm}{\abcbf o}
\bfm 62 \newcommand{\bfm}{\abcbf p}
\bfm 63 \newcommand{\bfm}{\abcbf q}
\bfm 64 \newcommand{\bfm}{\abcbf r}
\bfm 65 \newcommand{\bfm}{\abcbf s}
\bfm 66 \newcommand{\bfm}{\abcbf t}
\bfm 67 \newcommand{\bfm}{\abcbf u}
\bfm 68 \newcommand{\bfm}{\abcbf v}
\bfm 69 \newcommand{\bfm}{\abcbf w}
\bfm 70 \newcommand{\bfm}{\abcbf x}
\bfm 71 \newcommand{\bfm}{\abcbf y}
\bfm 72 \newcommand{\bfm}{\abcbf z}

```

`\bfalpha` Lower-case Greek letters are obtained by `\bfalpha`, `\bfbeta`, etc. The command `\greekbf` is either `\boldsymbol` or `\bm`, depending on options `greekbs` or `greekbm`.  
`\bfbeta`  
`\bfdelta`  
`\bfepsilon` 73 `\newcommand{\bfalpha}{\greekbf \alpha}`  
`\bfvarepsilon` 74 `\newcommand{\bfbeta}{\greekbf \beta}`  
`\bfzeta` 75 `\newcommand{\bfdelta}{\greekbf \delta}`  
`\bfeta` 76 `\newcommand{\bfepsilon}{\greekbf \epsilon}`  
`\bftheta` 77 `\newcommand{\bfvarepsilon}{\greekbf \varepsilon}`  
`\bfvartheta` 78 `\newcommand{\bfzeta}{\greekbf \zeta}`  
`\bfgamma` 79 `\newcommand{\bfeta}{\greekbf \eta}`  
`\bfkappa` 80 `\newcommand{\bftheta}{\greekbf \theta}`  
`\bflambda` 81 `\newcommand{\bfvartheta}{\greekbf \vartheta}`  
`\bfmu` 82 `\newcommand{\bfgamma}{\greekbf \gamma}`  
`\bfnu` 83 `\newcommand{\bfkappa}{\greekbf \kappa}`  
`\bfxi` 84 `\newcommand{\bflambda}{\greekbf \lambda}`  
`\bfpi` 85 `\newcommand{\bfmu}{\greekbf \mu}`  
`\bfvarpi` 86 `\newcommand{\bfnu}{\greekbf \nu}`  
`\bfrho` 87 `\newcommand{\bfxi}{\greekbf \xi}`  
`\bfvarrho` 88 `\newcommand{\bfpi}{\greekbf \pi}`  
`\bfsigma` 89 `\newcommand{\bfvarpi}{\greekbf \varpi}`  
`\bfvarsigma` 90 `\newcommand{\bfrho}{\greekbf \rho}`  
`\bftau` 91 `\newcommand{\bfvarsigma}{\greekbf \varsigma}`  
`\bfupsilon` 92 `\newcommand{\bftau}{\greekbf \tau}`  
`\bfphi` 93 `\newcommand{\bfupsilon}{\greekbf \upsilon}`  
`\bfvarphi` 94 `\newcommand{\bfphi}{\greekbf \phi}`  
`\bfchi` 95 `\newcommand{\bfvarphi}{\greekbf \varphi}`  
`\bfpsi` 96 `\newcommand{\bfchi}{\greekbf \chi}`  
`\bfomega` 97 `\newcommand{\bfpsi}{\greekbf \psi}`  
`\bfiota` 98 `\newcommand{\bfomega}{\greekbf \omega}`  
99 `\newcommand{\bfiota}{\greekbf \iota}`  
100  
101  
`\bfGamma` Capital Greek letters are obtained by `\bfGamma`, `\bfDelta`, etc. The command `\greekbf` is either `\boldsymbol` or `\bm`, depending on options `greekbs` or `greekbm`.  
`\bfDelta`  
`\bfTheta`  
`\bfLambda` 102 `\newcommand{\bfGamma}{\greekbf \Gamma}`  
`\bfXi` 103 `\newcommand{\bfDelta}{\greekbf \Delta}`  
`\bfPi` 104 `\newcommand{\bfTheta}{\greekbf \Theta}`  
`\bfSigma` 105 `\newcommand{\bfLambda}{\greekbf \Lambda}`  
`\bfUpsilon` 106 `\newcommand{\bfXi}{\greekbf \Xi}`  
`\bfPhi` 107 `\newcommand{\bfPi}{\greekbf \Pi}`  
`\bfPsi` 108 `\newcommand{\bfSigma}{\greekbf \Sigma}`  
`\bfOmega` 109 `\newcommand{\bfUpsilon}{\greekbf \Upsilon}`  
110 `\newcommand{\bfPhi}{\greekbf \Phi}`  
111 `\newcommand{\bfPsi}{\greekbf \Psi}`  
112 `\newcommand{\bfOmega}{\greekbf \Omega}`  
  
`\bfzero` Bold zero. The command `\greekbf` is either `\boldsymbol` or `\bm`, depending on

options greekbs or greekbm.

```
113 \newcommand{\bfzero}{\greekbf 0}
```

### 3.2 Statistical operators and concepts

Statistical operators for covariance, expectation and variance.

```
\cov
\E 114 \DeclareMathOperator{\cov}{Cov}
\V 115 \DeclareMathOperator{\E}{E}
116 \DeclareMathOperator{\MSE}{MSE}
117 \DeclareMathOperator{\V}{V}

\inas
\inprob 118 \newcommand{\inas}{\overset{\scriptstyle a.s.}{\longrightarrow}}
\indist 119 \newcommand{\indist}{\overset{\scriptstyle d}{\longrightarrow}}
\plim 120 \newcommand{\inprob}{\overset{\scriptstyle p}{\longrightarrow}}
121 \DeclareMathOperator{\plim}{plim}
```

### 3.3 Matrix and mathematical operators

```
\tr
\vc 122 \DeclareMathOperator{\tr}{tr}
\vcs 123 \DeclareMathOperator{\vc}{vec}
\vch 124 \DeclareMathOperator{\vcs}{vecs}
\diag 125 \DeclareMathOperator{\vch}{vech}
\det 126 \DeclareMathOperator{\diag}{diag}
\rank 127 \DeclareMathOperator{\rank}{rank}

\argmin
\argmax 128 \DeclareMathOperator{\argmin}{arg\,min}
\sign 129 \DeclareMathOperator{\argmax}{arg\,max}
\ind 130 \DeclareMathOperator{\sign}{sign}
131 \DeclareMathOperator{\ind}{\mathbbm{1}}
```

### 3.4 Sets

`\bbN` Sets are obtained by `\bbR` for the real numbers, and similar for other sets.

```
\bbZ 132 \newcommand{\bbN}{\mathbb N}
\bbQ 133 \newcommand{\bbZ}{\mathbb Z}
\bbR 134 \newcommand{\bbQ}{\mathbb Q}
\bbC 135 \newcommand{\bbR}{\mathbb R}
136 \newcommand{\bbC}{\mathbb C}
```

### 3.5 Distributions

`\dBeta` Sets are obtained by `\bbR` for the real numbers, and similar for other sets.

```
\dBern 137 \DeclareMathOperator{\dBeta}{Beta}
\dBern 138 \DeclareMathOperator{\dBern}{Bern}
\dBern 139 \DeclareMathOperator{\dBin}{Bin}
\dF 140 \DeclareMathOperator{\dF}{F}
\dGam 141 \DeclareMathOperator{\dGam}{Gam}
\dInvGam 142 \DeclareMathOperator{\dInvGam}{InvGam}
\dInvW 143 \DeclareMathOperator{\dInvW}{InvW}
\dLaplace 144 \DeclareMathOperator{\dLaplace}{Laplace}
\dMN 145 \DeclareMathOperator{\dMN}{MN}
\dN 146 \DeclareMathOperator{\dN}{N}
\dPo 147 \DeclareMathOperator{\dPo}{Po}
\dt 148 \DeclareMathOperator{\dt}{t}
\dW 149 \DeclareMathOperator{\dW}{W}
\dWeib 150 \DeclareMathOperator{\dWeib}{Weib}
```