

Symbols and Acronyms

Roman Symbols	Meaning	Section First Introduced
A	area under a histogram	4.5.1
A	generic accuracy statistic	9.1.4
A	area under the ROC curve	9.4.6
A	amplitude error	9.8.5
A	amplitude of unshifted cosine	10.4.3
a	number of occurrences	2.3.1
a	plotting position constant	3.3.7
a	linear congruential generator multiplier parameter	4.7.1
a	regression intercept	7.2.1
a	hit (correct nonprobabilistic forecast)	9.2.1
\mathbf{a}	most significant linear combination, T^2 test	12.5.4
\mathbf{a}	canonical vector	14.2.1
\mathbf{a}	discriminant vector	15.2.1
\hat{a}	BC _a acceleration parameter	5.3.5
B	bias ratio	9.2.2
B	amplitude of unshifted sine	10.4.3
b	moving-blocks bootstrap block length	5.3.5
b	regression parameter	7.2.1
b	false alarm (nonprobabilistic forecast)	9.2.1
b	rank histogram bin	9.7.2
b^*	regularized regression parameter	7.5
\mathbf{b}	canonical vector	14.2.1
b_1, b_2	multivariate skewness and kurtosis statistics	12.3
C	(as superscript) complement	2.4.1
C	cost associated with adverse weather protection	9.9.1
C	amplitude of shifted cosine	10.4.2
C	misclassification cost	15.2.3
C_α	approximate critical value for K-S test	5.2.5
Corr	correlation	13.1.1
Cov	covariance	3.5.2
c	histogram binwidth scaling constant	3.3.5
c	generic constant	4.3.2
c	linear congruential generator increment parameter	4.7.1
c	threshold, or cutoff, level	7.3.2
c	missed nonprobabilistic forecast	9.2.1
c	climatological gridpoint value	9.8.3

Continued

Roman Symbols	Meaning	Section First Introduced
D	Thom's statistic for gamma distribution	4.4.5
D	decision threshold	9.9.1
$[D]$	diagonal matrix of standard deviations	11.3.2
D_i	difference in ranks	3.5.3
D_n	Kolmogorov-Smirnov test statistic	5.2.5
D_S	Smirnov (2-sample K-S) test statistic	5.2.5
D	Gerrity odds ratio	9.2.6
D^2	Mahalanobis distance	11.2.2
d	Durbin-Watson statistic	7.2.6
d	correct negative (nonprobabilistic forecast)	9.2.1
d	discrimination distance	9.4.5
d	domain size	9.8.5
d	vector dimension	9.7.2
d	distance	13.2.4
\det	determinant (of a matrix)	11.3.2
d_h	Hinkley statistic	3.4.1
E	Event	2.3.1
E	statistical expectation	4.3.2
$[E]$	matrix of eigenvector columns	11.3.3
e	base of natural logarithms	4.2.5
e	regression residual	7.2.1
e	expected transition count	10.2.3
\mathbf{e}	eigenvector	11.3.3
F	generic cumulative distribution function	4.4.1
F	a specific distribution and hypothesis test name	5.3.4
F	false alarm rate	9.2.2
F_0	a step function	9.5.1
F_n	empirical CDF for Kolmogorov-Smirnov test	5.2.5
F^{-1}	inverse cumulative distribution (quantile) function	4.4.1
f	probability density function	4.4.1
f	regression function	7.9.1
\hat{f}	kernel density function	3.3.6
f_A	aliased frequency	10.5.4
f_k	frequency of k th harmonic	10.5.2
G	number of groups, discriminant analysis	15.1
g	multinormality comparison statistic	12.3
H	hit rate	9.2.2
H_0	null hypothesis	5.1.3
H_A	alternative hypothesis	5.1.3
H_k	complex Fourier coefficient	10.5.3
h	kernel function	3.3.6
h	ANN activation function	7.8.2
I	information matrix	4.6.4
I	indicator function	8.3.1
I	Ignorance (logarithmic) score	9.4.7
I	number of matrix rows	11.3.2
$[I]$	identity matrix	11.3.2
I_x	incomplete beta function	4.4.6
i	rank of order statistic	3.3.7
i	unit imaginary number	10.5.3

Roman Symbols	Meaning	Section First Introduced
J	number of matrix columns	11.3.2
K	dimensionality of multivariate observation	3.6.1
K	number of regression predictors	7.2.6
K	order of autoregressive model	10.3.2
K	number of periodogram amplitudes	10.5.6
K_α	constant for approximate K-S test	5.2.5
k	time lag	3.5.4
k	negative binomial distribution waiting parameter	4.2.3
k	harmonic index	10.4.4
k_0	number of restricted parameters, likelihood ratio test	5.2.6
k_A	number of alternative parameters, likelihood ratio test	5.2.6
L	log-likelihood function	3.4.1
L	bootstrap confidence interval lower bound	5.3.5
L	time-series block length	5.3.5
L	location error	9.8.5
L	loss associated with adverse weather	9.9.1
L	length of projection vector	11.3.1
L	number of multiple variables in combined principal components	13.2.2
$[L]$	matrix of “left” singular vectors	11.3.5
M	linear congruential generator modulus parameter	4.7.1
M	number of candidate regression predictors	7.4.2
M	number of gridpoints	9.8.1
M	order of moving-average model	10.3.6
M	number of retained principal components	13.1.1
M	embedding dimension (delay window)	13.7.1
M	number of canonical pairs	14.2.1
m	extreme-value block size	4.4.7
m	number of withheld points in cross-validation	7.4.4
m	ensemble size	8.3
m	order of a Markov chain	10.2.6
\hat{m}	discriminant function midpoint	15.2.1
N	number of binomial trials	4.2.1
N	Marshall-Palmer distribution function	4.4.5
N	subsample size	9.4.3
N_C, N_D	numbers of concordant or discordant pairs	3.5.3
n	sample size	2.3.1
n'	effective sample size	5.2.4
n^*	number of nonequal pairs, sign-rank test	5.3.1
n_B	number of bootstrap samples	5.3.5
O	cumulative observation vector	9.4.9
o	observation value	9.1.2
P	incomplete gamma function	4.4.5
P	probability function for group membership	4.6.3
p	a specific probability	3.1.2
p	binomial distribution parameter, (Bernoulli trial probability)	4.2.1
p	probability of evidence in a hypothesis test	5.1.4
p	order of autoregressive process	12.4.2
Pr	probability	2.3.1
Q	odds ratio skill score (Yule’s Q)	9.2.3
q	generic distribution quantile	8.3.1
q_p	sample quantile associated with probability p	3.1.2

Continued

Roman Symbols	Meaning	Section First Introduced
[R]	sample correlation matrix	3.6.4
[R]	matrix of “right” singular vectors	11.3.5
R	average Return period function	4.4.7
R	Metropolis-Hastings ratio	6.4.2
R^2	coefficient of determination	7.2.4
R_1, R_2	sums of ranks, Wilcoxon test	5.3.1
R_1, R_2	discriminant classification regions	15.2.3
R_n	integrated precipitation amount	9.8.5
RI	relative (or reduction in) ignorance	9.4.6
r	Rayleigh distribution variate	4.7.4
r	mass-weighted average distance	9.8.5
r_1	sample lag-1 autocorrelation	3.5.4
r_C	canonical correlation	14.1.2
r_k	sample lag-k autocorrelation	3.5.4
r_{rank}	Spearman rank correlation	3.5.3
r_{xy}	Pearson correlation coefficient	3.5.2
S	Sample space	2.2.2
S	pseudo-random number seed	4.7.1
S	Mann-Kendall trend test statistic	5.3.2
S	generic sample statistic	5.3.5
S	structure error	9.8.5
S	spectral density function	10.5.5
[S]	Gandin-Murphy scoring matrix	9.2.6
[S]	sample covariance matrix	11.1.3
SS	generic skill score	8.3.3
S1	field gradient score	9.8.2
s	sample standard deviation	3.2.2
s	base rate (sample climatology)	8.2.3
s	number of states in a Markov chain	10.2.5
s^2	sample variance	3.2.2
s_{ens}	ensemble standard deviation	8.3.1
$s_{k,\ell}$	(co)variance between two variables	11.1.3
s_n	precipitation object center of mass	9.8.5
T	threshold parameter	13.3.3
[T]	transformation, or rotation matrix	11.3.2
T^2	Hotelling statistic	12.5.2
T_1, T_2, T_3	power transformation functions	3.4.1
T_i	teleconnectivity	3.6.7
T_i	rank of data differences, signed-rank test	5.3.1
T_{max}	maximum temperature	2.5
T_{min}	minimum temperature	2.4.4
T_0	time between effectively independent samples	5.2.4
T^+, T^-	sums of ranks of differences, signed-rank test	5.3.1
t	t -test statistic	5.2.1
t	time	7.3.2
t_j	number of repeated values, Wilcoxon-Mann-Whitney test	5.3.1
tr	trace (of a matrix)	11.3.2
U	bootstrap confidence interval upper bound	5.3.5
U	unresolved tendency	8.2.4
U, U_1, U_2	Mann-Whitney statistic	5.3.1
u	horizontal velocity component	3.5.2

Roman Symbols	Meaning	Section First Introduced
u	POT sampling threshold	4.4.7
u	standard uniform variate	4.7
\mathbf{u}	principal component vector	13.1.1
V	verification (observed value)	8.3.1
V	ratio of verification	9.2.2
V	mass-weighted scaled volume	9.8.5
V	potential economic value	9.9.2
V	variance inflation factor	10.3.5
V	volume	12.1
Var	variance function	4.3.2
v	horizontal velocity component	3.5.2
v	canonical variate	14.2.1
W	Winkler's score	9.6.2
W	Wavelet coefficient	10.6
W	Ward clustering statistic	16.2.2
w	histogram binwidth	3.3.5
w	mixture distribution weighting parameter	4.4.9
w	Gerrity scoring weight	9.2.6
w	weighting function for spectral smoothing	10.5.6
w	canonical variate	14.2.1
$X_{()}$	order statistic (indicated by parenthetical subscript)	3.1.2
\bar{x}	sample mean of x	3.2.1
\bar{x}_{ens}	ensemble mean	8.3.1
x'	anomaly of x	3.4.3
Y	cumulative forecast vector	9.4.9
y	generic predictand, or forecast	7.2.1
Z	Fisher correlation transformation statistic	5.4.3
z	standardized anomaly	3.4.3
z	standard Gaussian variate	4.4.2
z	ANN hidden-layer variable	7.8.2
\hat{z}_0	BC _a bias correction parameter	5.3.5

Greek Symbols	Meaning	Section First Introduced
α	proportion of tail observations omitted in trimmed mean or variance	3.2.1
α	beta distribution parameter	3.3.7
α	gamma distribution shape parameter	4.4.5
α	Weibull distribution shape parameter	4.4.7
α	type I error rate (hypothesis level)	5.1.5
α_j	treatment effect coefficient	5.6.1
α	generic angle	10.4.1
α	learning rate parameter	16.4
α_{global}	global test level	5.4.1
β	beta distribution parameter	3.3.7
β	gamma distribution scale parameter	4.4.5

Continued

Greek Symbols	Meaning	Section First Introduced
β	exponential distribution mean	4.4.5
β	GEV distribution scale parameter	4.4.7
β	Weibull distribution scale parameter	4.4.7
β	type II error	5.1.5
β_1, β_2	mixed exponential scale parameters	4.4.9
Γ	gamma (factorial) function	4.2.3
γ	sample skewness coefficient	3.2.3
γ	Euler's constant (0.57721 ...)	4.4.7
γ_k	autocovariance function	3.5.5
γ_t	member-by-member "stretch" parameter	8.3.6
γ_{YK}	Yule-Kendall index	3.2.3
Δ	difference	3.4.3
δ	difference	12.5.2
δ_1	Fisher's linear discriminant function	15.2.1
ε	arbitrarily small number	2.3.1
ε	generic random number	10.3.1
ζ	Pearson III distribution shift parameter	4.4.5
ζ	GEV distribution location parameter	4.4.7
η	local regression bandwidth	7.7.1
θ	generic parameter value or vector	4.6.2
θ	odds ratio	9.2.2
θ	moving-average parameter	10.3.6
θ	generic angle	11.2.2
κ	(excess) Kurtosis	3.2.4
κ	GEV distribution shape parameter	4.4.7
κ	generalized Pareto distribution shape parameter	4.4.7
\mathcal{L}	likelihood function	4.6.1
\mathcal{L}^*	likelihood ratio test statistic (deviance)	5.2.6
λ	Box-Cox ("power") transformation parameter	3.4.1
λ	regularization parameter	7.5.1
λ	nearest-neighbor fraction	7.7.1
λ	eigenvalue	11.3.3
λ_2	L-scale	5.3.4
μ	generic distribution mean	4.2.3
μ	Gaussian mean parameter	4.1.2
μ	Poisson distribution mean parameter	4.2.5
μ_0	mean under null hypothesis	5.1.6
ν	degrees-of-freedom parameter for Chi-square distribution	4.4.5
ν	degrees-of-freedom parameter for t distribution	5.2.1
ξ	standard gamma distribution variate	4.4.5
π	3.14159 ...	4.4.2
$\pi(\mathbf{y})$	prerank of the vector \mathbf{y}	9.7.2
π	Markov chain stationary probability	10.2.2
ρ	bivariate Gaussian correlation parameter	
ρ_1	population (generating process) lag-1 autocorrelation	5.2.4
ρ_p	check function	7.7.3
ρ_k	lag- k autocorrelation	10.3.1
$[\Sigma]$	covariance matrix	4.6.4
σ	Gaussian standard deviation parameter	4.1.2
σ^2	generic distribution variance	4.2.3
σ^*	generalized Pareto distribution scale parameter	4.4.7
τ	Kendall correlation coefficient	3.5.3

Greek Symbols	Meaning	Section First Introduced
τ_k	period of k th harmonic	10.5.2
Φ	standard Gaussian cumulative distribution function	4.4.2
$[\Phi]$	matrix of autoregressive parameters	12.4.2
Φ^{-1}	standard Gaussian quantile function	4.4.2
ϕ	standard Gaussian probability density function	4.4.2
ϕ	autoregressive parameter	10.3.1
ϕ	phase shift, phase angle	10.4.2
ϕ	latitude	13.2.3
χ^2	Chi-square distribution variate	4.4.5
ψ	autoregressive forecast variance weight	10.3.7
ψ	wavelet function	10.6
$[\Omega]$	matrix of singular values	11.3.5
ω	average sampling frequency	4.4.7
ω	angular frequency	10.4.2
ω	singular value (in SVD)	11.3.5

Mathematical Operators	Meaning	Section First Introduced
\cup	union	2.4.1
\cap	intersection	2.4.1
$ $	conditional probability	2.4.3
Σ	series summation	2.4.5
Π	series product	3.3.6
$\binom{N}{x}$	combinatorial operator	4.2.1
$!$	factorial	4.2.1
$[\]^T$	vector or matrix transpose	11.1.2
$\ \ \ $	Euclidean distance	11.2.1
\otimes	dyadic (tensor) product	11.3.2
$ \ $	matrix determinant	11.3.2
$[\]^{-1}$	matrix inverse	11.3.2
$[\]^{1/2}$	matrix “square root”	11.3.4

Acronyms	Section First Introduced
A	
AC: Anomaly Correlation	9.8.4
AIC: Akaike Information Criterion	7.6.2
AKD: Affine Kernel Dressing	8.3.4
ANN: artificial neural network	7.8.2
ANOVA: ANalysis Of VAriance	5.6
AR: AutoRegressive	10.3.1
ARH: Average-Rank Histogram	9.7.2

Continued

Acronyms	Section First Introduced
ARMA: AutoRegressive-Moving Average	10.3.6
ASA: American Statistical Association	5.1.4
B	
BC _a Bias-Corrected and Accelerated	5.3.5
BHF: Bias/Hit rate/False alarm rate	9.2.4
BIC: Bayesian Information Criterion	7.6.2
BMA: Bayesian Model Averaging	8.3.4
BS: Brier Score	9.4.2
BSS: Brier Skill Score	9.4.2
BUGS Bayesian inference Using Gibbs Sampling	6.4.3
C	
CART: Classification And Regression Trees	15.6.2
CCA: Canonical Correlation Analysis	14.1
CCI: Central Credible Interval	6.2.2
CDF: Cumulative Distribution Function	4.4.1
CPCA: Combined Principal Component Analysis	13.2.2
CRPS: Continuous Ranked Probability Score	8.3.2
CSI: Critical Success Index	9.2.2
CSS: Clayton Skill Score	9.2.3
CTI: Cold Tongue Index	6.4.3
D	
df: Degrees of Freedom	7.2.3
DSS: Dawid-Sebastiani Score	9.5.3
E	
ECC: Empirical Copula Coupling	8.4.2
ECM: Expected Cost of Misclassification	15.2.3
ECMWF: European Centre For Medium-range Weather Forecasts	8.2.2
eCRPS: ensemble Continuous Ranked Probability Score	9.7.3
eES: ensemble Energy Score	9.7.4
EDA: Exploratory Data Analysis	3.1
EDI: Extremal Dependence Index	9.2.2
EE: Expected Expense	9.9.1
EEOF: Extended Empirical Orthogonal Function	13.2.2
EM: Expectation-Maximization (algorithm)	4.4.9
EMOS: Ensemble Model Output Statistics	8.3.2
EnKF: Ensemble Kalman Filter	8.2.2
ENSO: El Niño-Southern Oscillation	3.4.2
EOF: Empirical Orthogonal Function	13.1
erf: error function	4.4.2
ES: Energy Score	9.5.2
ETS: Equitable Threat Score	9.2.3
eVS: ensemble Variogram Score	9.7.4
F	
FAR: False Alarm Ratio	9.2.2
FDR: False Discovery Rate	5.4.2
FFT: Fast Fourier Transform	10.5.3
FSS: Fractions Skill Score	9.8.5
G	
GED: Gaussian Ensemble Dressing	8.3.4
GEV: Generalized Extreme Value (distribution)	4.4.7
GLM: Generalized Linear Model	7.6.1
GMSS: Gandin-Murphy Skill Score	9.2.6
GSS: Gilbert Skill Score	9.2.3

Acronyms	Section First Introduced
H	
HPD: Highest Posterior Density	6.2.2
HSS: Heidke Skill Score	9.2.3
I	
IQR: Interquartile Range	3.2.2
J	
JAGS: Just Another Gibbs Sampler	6.4.3
K	
K-S: Kolmogorov-Smirnov	5.2.5
L	
LAD: Least Absolute Deviation	7.2.1
LEV: Log-EigenValue	13.3.2
LQ: Lower Quartile	3.1.2
LS: Linear Score	9.4.8
M	
MA: Moving Average	10.3.6
MAD: Median Absolute Deviation	3.2.2
MAE: Mean Absolute Error	9.3.1
MBMP: Member-by-Member Postprocessing	8.3.6
MCA: Maximum Covariance Analysis	11.3.5
MCMC: Markov Chain Monte Carlo	6.4.1
MDA: Multiple Discriminant Analysis	15.3
ME: Mean Error	9.3.1
MECE: Mutually Exclusive and Collectively Exhaustive	2.2.2
MJO: Madden-Julian Oscillation	12.2.2
MLE: Maximum Likelihood Estimator	4.6.1
MODE: Method for Object-based Diagnostic Evaluation	9.8.5
MOS: Model Output Statistics	7.9.2
MRH: Multivariate Rank Histogram	9.7.2
MS: Mean Squared	7.2.3
MSA: treatment mean squares	5.6.1
MSSA: Multichannel Singular Spectrum Analysis	13.7.1
MSE: Mean Squared Error	5.6.1
MSR: Regression Mean Square	7.2.3
MST: Minimum Spanning Tree	9.7.3
MVN: MultiVariate Normal distribution	12.1
N	
NAO: North Atlantic Oscillation	6.4.3
NCEP: National Centers for Environmental Prediction	8.1.5
NGR: Nonhomogeneous Gaussian Regression	8.3.2
NHC: National Hurricane Center	7.9.1
O	
OLR: Outgoing Longwave Radiation	12.2.2
OLS: Ordinary Least Squares	7.2.1
ORSS: Odds Ratio Skill Score	9.2.3
P	
PC: Proportion Correct	9.2.2
PC: Principal Component	13.1.1
PCA: Principal Component Analysis	13.1
PDF: Probability Density Function	4.4.1
PIT: Probability Integral Transform	4.7.2
POD: Probability Of Detection	9.2.2
POFD: Probability Of False Detection	9.2.2

Continued

Acronyms	Section First Introduced
PoP: Probability of Precipitation	7.10.2
POT: Peaks Over Threshold	4.4.7
PNA: Pacific-North America	3.6.7
P-P: Probability-Probability	4.5.2
PSS: Peirce Skill Score	9.2.3
Q	
Q-Q: Quantile-Quantile	4.5.2
QS: Quantile Score	9.6.1
R	
RA: Redundancy Analysis	14.4
REEP: Regression Estimation of Event Probabilities	7.6.2
REL: RELiability	9.4.3
RES: RESolution	9.4.3
RI: Reliability Index	9.7.1
RMSE: Root Mean Squared Error	8.2.3
ROC: Relative (or, Receiver) Operating Characteristic	9.4.6
RPS: Ranked Probability Score	9.4.9
RV: Reduction of Variance	9.3.2
S	
SAL: Structure-Amplitude-Location method	9.8.5
SAT: Scholastic Aptitude Test	7.4.1
s.e.: standard error	7.2.5
SOI: Southern Oscillation Index	5.4.3
SOM: Self-Organizing Map	16.4
SPI: Standardized Precipitation Index	4.4.5
SS: Sum of Squares	7.2.3
SSA Treatment sum of squares	5.6.1
SSB Block-effect sum of squares	5.6.2
SSA: Singular Spectrum Analysis	13.7.1
SSE: Error Sum of Squares	5.6.1
SSR: Regression Sum of Squares	7.2.2
SST: Total Sum of Squares	5.6.1
SST: Sea-Surface Temperature	14.2.3
ST-EOF: Space-Time Empirical Orthogonal Function	13.7.1
SVD: Singular Value Decomposition	11.3.5
SVM: Support Vector Machine	15.6.1
T	
T-EOF: Time-Empirical Orthogonal Function	13.7.1
T-PC: Time-Principal Component	13.7.1
TS: Threat Score	9.2.2
TSS: True Skill Statistic	9.2.3
U	
UNC: UNCertainty	9.4.3
UTC: Universal Time Coordinated	7.9.3
UQ: Upper Quartile	3.1.2
V	
VS: Value Score	9.9.2
W	
W Winkler score	9.6.2
X	
XLR: Extended Logistic Regression	8.3.3