

LIST OF NOTATIONS

<u>Symbol</u>	<u>Explanation</u>	<u>Page (of first use)</u>
$[a, b[$	all real numbers $x$ such that $a \leq x < b$	11
$\log_{10} x$	the logarithm (to the base 10) of $x$	15
$a^x$	the exponential function $f(x) = a^x$	15
$\log_a x$	the logarithm (to the base $a$ ) of $x$	16
$x^a$	the power function $f(x) = x^a$	16
$\sum_{i=1}^N x_i$	$x_1 + x_2 + \dots + x_N$	18
$\bar{x}$	the mean (or the weighted mean)	18
GM	the geometric mean	19
HM	the harmonic mean	19
Md	the median	19
Mo	the mode	20
$\sigma$	the standard deviation	22
MD	the mean deviation	23
$Q_j, P_j$	the $j^{\text{th}}$ quartile resp. $j^{\text{th}}$ percentile	23
V	the coefficient of variation	23
$m_r, m_r'$	$r^{\text{th}}$ moments	23
$\Omega$	universum	26
$P(A)$	probability of $A$	26
$A^c$	complement of $A$	26
$\phi$	empty set	26
$P(A B)$	conditional probability	26 - 27

$X$	stochastic variable or random variable	28
$\int_{x_1}^{x_2} f(x)dx, \int_{-\infty}^{+\infty} f(x)dx, \int_{-\infty}^x f(x)dx$	the integral of $f$ , definite resp. improper	29
$F$	cumulative distribution	29
$\frac{dF}{dx} = F'$	the derivative of $F$	29
$E(X)$	mean or expectation of $X$	30
$\text{Var}(X)$	variance of $X$	30
$\binom{n}{x}$	$\frac{n!}{x!(n-x)!}$ , where $n! = n(n-1) \dots 3.2.1$	31
$\pi$	'pi', $\pi = 3.1415927\dots$	32
$\chi^2$	Chi-square	34
$\Gamma$	$\Gamma$ -function	34
$\square$	end of the proof	36
$\bar{X}$	sample mean	41
$S^2$	sample variance	41
$H_0, H_1$	null resp. alternative hypothesis	42
$O(k), E(k)$	observed resp. expected	52
$O_{ij}, E_{ij}$	number	55
$D$	Kolmogorov-Smirnov statistic	57
$U$	Mann-Whitney statistic	60
$R$	number of runs	61
$S_{X,Y}$	sample covariance	62
$\text{Cov}(X,Y)$	covariance of $X$ and $Y$	63
$R_{X,Y}$	sample correlation coefficient	63
$\rho(X,Y)$	correlation coefficient of $X$ and $Y$	63

$\frac{\partial f}{\partial a}$	partial derivative of $f$	65
$R_s$	Spearman rank correlation	69
$\tau$	Kendall's tau	71
$\text{sgn}(x)$	the sign of $x$	72
$\# A$	cardinality of $A$ = the number of elements in $A$	88
$C = (c_{ij})$	the matrix $C$	99
$\mathbb{R}^k$	$k$ -dimensional space, $k = 1, 2, 3, \dots$	99
$+9.11 \text{ E-}08$	$\frac{9.11}{10^8}$	103
$d, d_i$	distance, metric, dissimilarity	105 - 107
$s$	similarity	108
$\text{Arctg}$	Arctangent	108
$D_i$	distance or dissimilarity matrix	112 - 113
$\text{ESS}$	error sum of squares	119
$E$	$E = \sum_{i=1}^{K-1} \text{ESS}_i$	119
$C^t$	the transpose of the matrix $C$	130 - 131
$:=$	equal, by definition	146
$\bar{N}_q, \bar{N}_s, \bar{N}$	the average number of items in the queue, resp. in service, resp. in the whole system	158
$\lambda, \mu$	the expected arrival resp. service rate	158
$\bar{T}_q, \bar{T}_s, \bar{T}$	the average time spent in the queue, resp. at the desk, resp. in the whole system	158
$\rho$	the utilisation factor	158 - 159
$m$	the number of servers	159
$(A B m)$	queueing situations	159
$(M M m)$		

$R, R_t$	the average number of times an item is loaned out during a year	167,178
$P_1, P_0$	the probability that an item will (resp. will not) be available	169
$U, U_i$	degree of dissatisfaction	169,180
$(S_n)$	stochastic process	175
$P = (p_{ij})$	transition matrix	176
$T_m$	the stochastic variable of the number of loans of those books that were borrowed $m$ times last year	178
$N(m)$	$N(m) = E(T_m)$	178
$T_{mn}$	$T_{mn} = P(T_m = n)$	178
$P_r(t)$	the probability that a book will be on loan $r$ times	184
$T$	time period	185
$1/\alpha$	a proportionality factor	185
$\delta$	$\delta = \frac{T}{T+\alpha}$	186
$\beta$	the fraction of the collection that consists of 'dead' books	186
$\hat{\beta}, \hat{\delta}, \dots$	maximum likelihood estimators of $\beta, \delta, \dots$	186
$\ln$	$\ln = \log_e$	191
$\gamma$	Euler's number $\gamma \approx 0.5772$	192
$\mu_A$	membership function	197
$C(d)$	the set of all references in document $d$	231
$C^{-1}(d)$	the set of all citations to document $d$	231
$\forall$	for every (for all)	238
$Z \hat{X} S$	angle $Z \times S$	245

sin	sine	244
Arccos	Arccosine	244
JCR	Journal Citation Reports	254
IPF	Impact factor	255
IMI	Immediacy Index	255
CIT	number of citations	256
PUB	number of publications	256
a	ageing factor	268
$\vec{c} = (c_x, c_y)$	centre of publication	280
AI	Activity index	285
AAI	Attractivity index	285
$S_j$	Jaccard index	288
$S_s$	Salton's cosine function	289
IPP	Information Production Process	292,313
f	Lotka's function	293,318
T	total number of sources	293,313
r	rank	293,313
g	Zipf's or Mandelbrot's function	294,322
h	Pareto's function	294
R	(general) Leimkuhler's function	295,322,334
A	total number of items	295,313
$r_0, \gamma_0, k, p$	parameters appearing in Bradford's law	295,322
SBS	success-breeds-success	297

$\varphi$	Lotka's function	297
$\frac{\partial}{\partial T}$	partial derivative	299
B	the beta function $B(j,m) = \frac{(j-1)!(m-1)!}{(j+m-1)!}$	301
$\lambda$	Lebesgue measure	305
$D_S$	the fractal dimension or similarity dimension	307,310
D	the Hausdorff-Besicovitch dimension	310
$(S,I,V)$	an IPP where $S = [0,T]$ , $I = [0,A]$ , and $V$ is a function $V : S \rightarrow I$	313
$(I,S,U)$	the dual IPP of $(S,I,V)$	313
$V^{-1}$	the inverse function of $V$	313
$\sigma$	$\sigma = U'$ , (general) Bradford function	314,322,334
$\rho$	$\rho = V'$	314
K	group-free Bradford factor in Bradford's function	316
$r_d$	abscissa of the Groos droop	340,350
$y_m$	the number of items in the most productive source	341
$m(i)$	the number of items in the most productive source in the $i^{\text{th}}$ group (counted from the least productive source on)	342
$[r_0]$	largest whole number smaller than or equal to $r_0$	344
$\zeta$	the zeta function ( $\alpha > 1$ ) $\zeta(\alpha) = \sum_{j=1}^{\infty} \frac{1}{j^\alpha}$	356
$x = x(\theta)$	generalised '80/20-rule'	362
$\alpha = \alpha(\theta)$	generalised 'law of Price'	362
f	general concentration measure	363
$\pi$	permutation	363
V	coefficient of variation	365

Ga	Gaston's measure	366
A	Allison's modified squared coefficient	366
K	Yule characteristic	366
J	Simpson's index	366
D	Schutz coefficient	366
C	Pratt's measure	367
G	Gini's index	367
Th	Theil's measure	367
L	Variance of the logarithm	367
A(e)	Atkinson's index	367
CON	the CON-index	368
$\alpha$	Lotka's $\alpha$	368
P(r)	generalised Pratt measure	369
H	Entropy measure	371
$(S(t), I(t), V_t)$	time-dependent IPP	381
P(t)	Population size	381

## I N D E X

80/20 rule	191, 361
absolute scale	10
academic libraries	192
activity index	285
adjusted counts	223, 276
ageing	192, 194, 268
ageing factor	193, 268
ageing rate	268
agglomerative methods	120
allocation of funds	137, 376
alphabetically ordered	223
anomalous numbers (law of)	376
applications	361, 376
Applied Geophysics	7, 294
approximations	341
archival journals	272
arcs near the end of a Leimkuhler curve	354
arithmetic mean	18, 19
arrival rate	158
arrivals	52
artificial intelligence	201, 252
Arts & Humanities Citation Index (A&HCI)	205, 208
Arts & Humanities Search	209
assignment problems	133, 135
Atkinson's index	367
Atlas of Science	242, 253
attractivity index	285
automatic classification	123
automation	89
average	18, 232
average linking clustering	117
bar charts	13
bar codes	166
Bayes' rule	27
Bayesian methods	195
Behrens-Fischer problem	51
Bernoulli trials	31, 90
beta distribution	301
beta mixture of binomial distributions	195
bias	74, 91, 219, 220
bibliographic coupling	234, 235, 239, 242
bibliographies	292
bibliometrics	1, 2, 292
binding	136, 199
binomial distribution	31, 90
biometrics	3
book circulation	167
book shelves	83
booksellers	49
Bookstein A.	301
Bose-Einstein distribution	38, 374
botany	102
box-and-whisker plots	25



Bradford factor	295,332,383
Bradford groups	352
Bradford S.	7,361
Bradford's law	209,295,316,343,372,383
branch-and-bound	133
Brookes' law	375
Brooks T.	214,383
browsing	194
Burrell's simple model for library loans	183
canonical primal problem	131
card files	79
cataloguing	158
CD ROM	209,239
cell occupancy problems	36
central limit theorem	43
central tendency (measures of)	18
centre of publication/citation	280
chaining	116
Chapman-Kolmogorov equation	181
Chebyshev distance	107
chemometrics	3
chi-square distribution	34
chi-square tests	52,53,55,246
Chubin-Moitra classification scheme	213
circle model	243
circulation desk	158,162,
citation analysis	203,216,224,252,254
citation context analysis	251
citation graphs	228,230,250
Citation Index	207
citation indexes/indexing	204,205,209
citation matrices	228,232,233
citation measures	262
citation networks	228
citation potentials	265
citation threshold	216
citations	204,211,234
cited	99,207,221,293,317
cited half-life	256,270
Cited Journal Listing	259
citers' motivations	211,214,216
citing	99,207,221,293,317
Citing Journal Listing	258
city-block metric	106
classifications	212,213,238
cluster analysis	112
clusters	242
co-authorship	220,222,233,275
co-citation	234,235,239,243,288
co-citation histories	246
co-occurrence of ideas	242
coefficient of determination	68
coefficient of variation	23,365
cognitive space	252
collaboration (measures)	89,233,377
collection policies	265,289
compact book storage	150,156

complete balking	168,172
complete link clustering	116
compression	370
computer science	-
CON-index	368,370
concentration	362,363
concentration measures	363,365
conceptual	213
conditional expectation	260
conditional probabilities	26,261
confidence intervals	47,91
confirmative	213
content elements	6
contingency tables	54
continuity corrections	54,61,62
continuous stochastic variables	28
Corporate Index	208
correlation	62,63,95,96
cost vector	131
counting	10
covariance	62,63
creativity	19
crisp sets	197
cumulative advantage distribution	301
cumulative distribution functions	29
cutting-off method	351
cycling	232
data processing	158
dead items	186
decision vector	131
defensive collection policy	265
degree of clustering	87
delivery vans	157
demography	72,292
dendrograms	112,141
dense sets	326
density functions	29
descriptive statistics	6
developing countries	227
deviations from Leimkuhler's function	351
diachronous studies	268,271
difference equations	262
difference scale	9
Dijkstra's shortest path algorithm	145,148,156
dimensionality-reducing techniques	94
directed graphs	141,175,231
discrete stochastic variables	28
dispersion (measures of)	21,370
dissatisfaction (degree of)	169,171
dissimilarities	107
distances	105
distribution-free methods	59
distribution functions	28
double-logarithmic representation	15
downloaded data	2
dual IPP	313
duality	313,315

econometrics	3,291,292,367,377
eigenvalues/eigenvectors	100
empirical laws	293
English	219
entropy (measure)	266,371,376
eponyms	218,226
equipment replacement	148
Erlang distribution	160
Erlang's lost call equation	172
error bars	47
errors	42,220
estimation	98
Estoup's law	373
ethics	226
evaluations	203
events	26
evolutionary	213
expectation	30
expertise/experts	200
explained variation	67
explanations	297,373
exponential growth	381
extended transfer principle	369,377
false drops	56
feasible region	127
feasible solutions	127,129
Fermi-Dirac distribution	38
field differences/variations	219,226
first come, first served	159
fitting methods	343,355
fluctuations	219,262
fractal dimension	310,312
fractal theory	306,308
fractional counts	276
fractions	46,93
frequency distributions	10
frequency polygons	10,11
furthest neighbour linking	116
Fussler sampling technique	78,88
fuzzy set theory	197,201,216
gamma distribution	189
gamma function	34,190
gamma mixture of Poisson processes	188,190,195
Garfield E.	205,219
Gaussian distribution	32
general Leimkuhler function	334,355
general Lotka function	320,322,334,355
general Zipf function	294,308
generalised impact factor	264
generalised inverse Gaussian-Poisson distribution (GIGP)	374
generalised Pratt measure	369
geometric distribution	34,186
geometric mean	19,366
Gini index	366,377
goodness of fit	52,57
graphical perception	17

graphical representations	10
graphs	141
Groos droop	340,349,350
ground plan	144
group average clustering	117
group-free Bradford factor	316,333
group-free law of Bradford	316,322,334
grouped data	24
growth	380,381,382
half-life	256,267,270
harmonic mean	19
Hausdorff-Besicovitch dimension	310,338
heuristic methods	156,199
hierarchical methods	120
histograms	10,11,13
history of science	3,287
homographs	218
hyperplane	95
hypotheses	41,42
immediacy index	255
impact factors	70,225,255,260,263
implicit citations	208,218
imprecision	197
in-library use	76
incompleteness	219,351
independence	27,54
index approach	375
indexing	204
indicators of international scientific activity	284
indirect influences	287
inferential statistics	41
inflection points	340,350
information production processes (IPP)	4,292,308,313
information retrieval	3,201,203,238
information transfer	373
informetric laws	289,297,343,372
informetric models	291
informetrics	1,2,3,376,378
Institute for Scientific Information (ISI)	205,219
integer programming	132
interarrival times	159,163
intercept	65
interlibrary lending/loan	89,135
interdisciplinarity	351
international co-authorship	279
interquartile range	23
interval scale	9
item relationship	318
items	292,313
Jaccard index	288
Journal Citation Reports (JCR)	207,254
Journal Half-Life Listing	257
Journal Rankings	254
journal selection	139,209
journals	102,254

juxtapositional	213
Karmarkar's algorithm	140
Kendall's tau	71
Kessler	235
kinematic statistics	280
Koch curve	310
Kolmogorov-Smirnov test	57
kurtosis (coefficient of)	24
language barrier	289
last come, first served	159
least effort (principle of)	373
least squares method	356
Leimkuhler function	295,322,345
level of significance	42
librametrics	1
library allocation	124
library and information science	1,139,291
library circulation models	178,183
library management	3,125,289
linear function	129
linear functional	129
linear programming	126,129,133,139
linear regression	65
linguistics	292,366,375
Little's equation	159
log-normal distribution	373
logarithmic scales	15
logarithms	15
logical references	239
logistic growth	382
Lorenz curve/order	367,377
lost books	93
Lotka distribution/function	191,293,301,319,320,322
Lotka's alfa	369
Lubrication	295,343
(MIG11) queue	165
(MIM11) queue	160,170
(MiMim) queue	163,173
Mandelbrot distribution/function	294,306,312,322,334
Mann-Whitney U-test	59
many-to-many relations	380
Markov processes	175,177,178
mathematics	1
matrices	233
Matthew effect	374
maximum likelihood (estimators)	186,358
maximum problems	129,130
Maxwell-Boltzmann distribution	36
mean	18,30,41,44,47,49,92
mean deviation	22
mean response rate	265
measurement	1,9
median	19
median citation age	268
merging	351

meta-information	1
methodological papers	226
metric space	106
minimum problems	129
Minkowski metric	106
misprints	38
MIT	182
modal class	20
mode	20
model-building	1,98,203,291
model specification	98
moments	23
monotonicity constraint	110
Morse's Markov model for book use	178,194
multidimensional scaling techniques (MDS)	105,245
multidisciplinarity	210,351
multiple authorship	217,220,275,303
multiple choice integer programs	139
multiple copies	172,181
multiple discoveries	32
multiple regression	95,98
multiple travelling salespersons problem	156
multivariate statistics	94
Murphy data	358
music scores	208
n-dimensional informetrics	378
nearest neighbour clustering	114
negational	213
negative binomial distribution	34,190,193,260
negative exponential distribution	34,160,185
network studies	102,241
noblesse oblige	223
noise	220
nominal increase	364
nominal scale	9
non-metric multidimensional scaling	110
nonparametric tests	59
normal counts	223,275
normal distribution	32,52
NP-complete	155
nuclear zone/nucleus	354,361
objective function	128,129
obliteration by incorporation	219
obsolescence	194,267,273,380
online	208
online systems	27,89
operational	213
operations research	125
optimal solution	128,129
ordinal scale	9
organic	213
Ortega hypothesis	288
overlap	47,88
parameter estimation	98
parametric techniques	32,59

Pareto	294,339,373,375
Pascal's distribution	34
Patent Citation Index	207
patents	207
Pearson's correlation coefficient	63,68
percentiles	23
periodicals	199
Permuterm Subject Index	207,208
persuasion	215
Philadelphia Program	227
physics	3
Pinski-Narin influence measure	263
Poisson distribution	31,52,160,179,185,189,261
Polaczek-Khintchine equation	165
pooling	164
Pope's bibliography	346
Popper's World 3	280
Pratt's measure	366,377
prediction	98
predictor variables	95
Price's law	362,377
principal components analysis (PCA)	98
principal coordinate analysis	110
priority queues/service	159
probability density functions	29
probability theory	26,165
product-moment correlation coefficient	63,68
profit vector	131
projection	99,100,101
prospective coupling	239
pseudo-random numbers	76
public libraries	142,191,192
publication matrices	233
publications	292
pure duality	315
quantitative linguistics	3,292
quartiles	23
questionnaires	6,68,73
queueing theory	158,165,167,182
Radhakrishnan-Kerdizan data	359
random graph hypothesis	120,250
random permutations	76,
random sampling	74,75
random variables	28
randomness	160
range	22
rank correlation	69
rank-order distributions	293
ratio scale	9
recognisable objects	36
recognition	374
redundant citations	213,252
references	10,204,234
regression	62,94,95
relational databases	201
relative co-citation	240

relative concentration	376
relative errors	92
replacements	149
requirement vector	131
research front journals	272
reservations	170,173
resolution	18
retrieval	238,371
retrospective coupling	239
reviews	239
reward system in science	226
Rousseau's law	377
runs test	61
Salton's (cosine) equation	288
sample mean	41
sample size	92
sample space	26
sample variance	41
sampling	41,74,223,372
Saskatchewan	182,195
scale invariance	364
scales	9
scatterplots	64
Schutz coefficient	366
Science Citation Index (SCI)	10,205,206,208,239
science policy	2,3,274
scientific journals	254
scientific specialties	241
Scientometrics	285,288
scientometrics	1,2
SciSearch	209
search keys	55
self-citations	217,220
self-cited rate	260
self-citing rate	260
self-similar fractals	310
semantic difficulties	210
semi-logarithmic representation	15
service rate	158
service time distribution	160,163
sex bias	220
Shepard's citations	205
shortest path algorithms	141,145,152
significance	41,42
similarities	107,289
simplex method	129,132
Simpson's index	366
single link clustering	114,116
skewness (coefficient of)	23
slack variables	131
slope	65,69
smoothing techniques	20
Social Science Citation Index (SSCI)	205,206,208
Social SciSearch	209
sociology of science	3
sociometrics	3
Source Data Listing	257

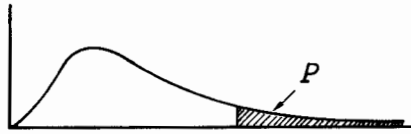


Source Index	207,208
source items/publications	10,204
source journals	206
source-relationship	318
sources	292,313
sources (types of)	218
spatial relationships	142
Spearman rank correlation coefficient	69
specialty narratives	253
speed	78
standard deviation	22,365
standard dual minimum problem	131
standard normal distribution	33,44
standard primal maximum problem	130
standard scores	24
standardisation	109
stationary Markov processes	176
statistical bibliography	1
steady state distribution	176
stochastic processes	159,175,183
stochastic variables	28
stock relegation	187
stopping times	382
storage	371
straight counts	222,275
straight-line phenomenon	183,185
straight lines	65,183
stratified random sampling	77
Student's t-distribution	35,44
stylistic properties	370
subject indexes	209
subject similarity	242
success-breeds-success (SBS)	297,374
superspecialisation	228
synchronous studies	268,271
synonyms	218
systematic sampling	77
t-distribution	35,44
t-test	44,68
tables	6,8
tests of hypotheses	41,42
texts	310
Theil's measure	367
theory	1
thermodynamic principles	40
thickness	83
Third World science	227
Thorne	212
ticket windows	158
time-dependent studies	386
time series analysis	68
total variation	67
transfer principle	364
transitions	175
transportation (problems)	133,148,158
travelling salesperson problem (TSP)	154
trees	141,213

tri-citation	243
two stage sampling	93
type I/II errors	42
U-test	59
ultrametrics	120
unbiased estimators	41
uncited	261
unexplained variation	67
union catalogues	89
universe	26
unrecognisable objects	37
utilisation factor	158,161
variance	22,30,41,52,365
variance-covariance matrix	100
variance of logarithms	367
visibility	260
visualisation	99
waiting facilities (in queuing theory)	168
Wald-Wolfowitz runs test	40,61
Ward's error sum of squares method	118
Waring distribution	373
weakly connected	231
Weber-Fechner law	375
weighted average/mean	18,20
weighted graphs	141,152,176
weighting methods	274
Weinstock	211
Welch-Aspin method	51
Yates' correction	54,55
Yule characteristic	366
z-test	44,51
zero class	186
zeta function	356,357
Zipf's law	40,293,308,339,373,375
Zipfian distributions/functions	371,378

LIST OF TABLES

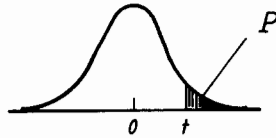
Table A.1

Standard Normal Cumulative Distribution Function  $\Phi(z)$ 

$$\Phi(z) = \int_{-\infty}^z \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt$$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
1- $\alpha$	0.90	0.95	0.875	0.99	0.995	0.999	0.9995	0.99995	0.999995	
z	1.282	1.645	1.960	2.326	2.576	3.090	3.291	3.891	4.417	

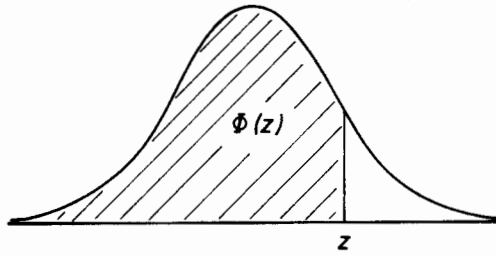
Table A.2

Student's *t*-Distribution

The first column lists the number of degrees of freedom ( $\nu$ ). The headings of the other columns give probabilities ( $P$ ) that  $t$  exceeds the entry value. Use symmetry for negative  $t$ -values.

$\nu$	$P$				
	.10	.05	.025	.01	.005
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
40	1.303	1.684	2.021	2.423	2.704
60	1.296	1.671	2.000	2.390	2.660
120	1.289	1.658	1.980	2.358	2.617
$\infty$	1.282	1.645	1.960	2.326	2.576

Table A.3

Chi-Square Distribution with  $\nu$  Degrees-of-Freedom

$\nu$	0.250	0.100	0.050	0.025	0.010	0.005	0.001
1	1.32	2.71	3.84	5.02	6.63	7.88	10.83
2	2.77	4.61	5.99	7.38	9.21	10.60	13.82
3	4.11	6.25	7.81	9.35	11.34	12.84	16.27
4	5.39	7.78	9.49	11.14	13.28	14.86	18.47
5	6.63	9.24	11.07	12.83	15.09	16.75	20.52
6	7.84	10.64	12.59	14.45	16.81	18.55	22.46
7	9.04	12.02	14.07	16.01	18.48	20.28	24.32
8	10.22	13.36	15.51	17.53	20.09	21.96	26.12
9	11.39	14.68	16.92	19.02	21.67	23.59	27.88
10	12.55	15.99	18.31	20.48	23.21	25.19	29.59
11	13.70	17.28	19.68	21.92	24.72	26.76	31.26
12	14.85	18.55	21.03	23.34	26.22	28.30	32.91
13	15.98	19.81	22.36	24.74	27.69	29.82	34.53
14	17.12	21.06	23.68	26.12	29.14	31.32	36.12
15	18.25	22.31	25.00	27.49	30.58	32.80	37.70
16	19.37	23.54	26.30	28.85	32.00	34.27	39.25
17	20.49	24.77	27.59	30.19	33.41	35.73	40.79
18	21.60	25.99	28.87	31.53	34.81	37.16	42.31
19	22.72	27.20	30.14	32.85	36.19	38.58	43.82
20	23.83	28.41	31.41	34.17	37.57	40.00	45.32
21	24.93	29.62	32.67	35.48	38.93	41.40	46.80
22	26.04	30.81	33.92	36.78	40.29	42.80	48.27
23	27.14	32.01	35.17	38.08	41.64	44.18	49.73
24	28.24	33.20	36.42	39.36	42.98	45.56	51.18
25	29.34	34.38	37.65	40.65	44.31	46.93	52.62
30	34.80	40.26	43.77	46.98	50.89	53.67	59.70
40	45.62	51.80	55.76	59.34	63.69	66.77	73.40
50	56.33	63.17	67.50	71.42	76.15	79.49	86.66
60	66.98	74.40	79.08	83.30	88.38	91.95	99.61
70	77.58	85.53	90.53	95.02	100.42	104.22	112.32
80	88.13	96.58	101.88	106.63	112.33	116.32	124.84
90	98.64	107.56	113.14	118.14	124.12	128.30	137.21
100	109.14	118.50	124.34	129.56	135.81	140.17	149.45

Table A.4  
Quantiles of the Kolmogorov test statistic

One-sided test Two-sided test	$p = 0.90$ $p = 0.80$	0.95 0.90	0.975 0.95	0.99 0.98	0.995 0.99
N = 1	.900	.950	.975	.990	.995
2	.684	.776	.842	.900	.929
3	.565	.636	.708	.785	.829
4	.493	.565	.624	.689	.734
5	.447	.509	.563	.627	.669
6	.410	.468	.519	.577	.617
7	.381	.436	.483	.538	.576
8	.358	.410	.454	.507	.542
9	.339	.387	.430	.480	.513
10	.323	.369	.409	.457	.489
11	.308	.352	.391	.437	.468
12	.296	.338	.375	.419	.449
13	.285	.325	.361	.404	.432
14	.275	.314	.349	.390	.418
15	.266	.304	.338	.377	.404
16	.258	.295	.327	.366	.392
17	.250	.286	.318	.355	.381
18	.244	.279	.309	.346	.371
19	.237	.271	.301	.337	.361
20	.232	.265	.294	.329	.352
21	.226	.259	.287	.321	.344
22	.221	.253	.281	.314	.337
23	.216	.247	.275	.307	.330
24	.212	.242	.269	.301	.323
25	.208	.238	.264	.295	.317
26	.204	.233	.259	.290	.311
27	.200	.229	.254	.284	.305
28	.197	.225	.250	.279	.300
29	.193	.221	.246	.275	.295
30	.190	.218	.242	.270	.290
31	.187	.214	.238	.266	.285
32	.184	.211	.234	.262	.281
33	.182	.208	.231	.258	.277
34	.179	.205	.227	.254	.273
35	.177	.202	.224	.251	.269
36	.174	.199	.221	.247	.265
37	.172	.196	.218	.244	.262
38	.170	.194	.215	.241	.258
39	.168	.191	.213	.238	.255
40	.165	.189	.210	.235	.252
Approximation for $N > 40$ :	<u>1.07</u> $\sqrt{N}$	<u>1.22</u> $\sqrt{N}$	<u>1.36</u> $\sqrt{N}$	<u>1.52</u> $\sqrt{N}$	<u>1.63</u> $\sqrt{N}$

Table A.5  
Mann-Whitney U-statistic

m \ n	9	10	11	12	13	14	15	16	17	18	19	20
1											0	0
2	1	1	1	2	2	2	3	3	3	4	4	4
3	3	4	5	5	6	7	7	8	9	9	10	11
4	6	7	8	9	10	11	12	14	15	16	17	18
5	9	11	12	13	15	16	18	19	20	22	23	25
6	12	14	16	17	19	21	23	25	26	28	30	32
7	15	17	19	21	24	26	28	30	33	35	37	39
8	18	20	23	26	28	31	33	36	39	41	44	47
9	21	24	27	30	33	36	39	42	45	48	51	54
10	24	27	31	34	37	41	44	48	51	55	58	62
11	27	31	34	38	42	46	50	54	57	61	65	69
12	30	34	38	42	47	51	55	60	64	68	72	77
13	33	37	42	47	51	56	61	65	70	75	80	84
14	36	41	46	51	56	61	66	71	77	82	87	92
15	39	44	50	55	61	66	72	77	83	88	94	100
16	42	48	54	60	65	71	77	83	89	95	101	107
17	45	51	57	64	70	77	83	89	96	102	109	115
18	48	55	61	68	75	82	88	95	102	109	116	123
19	51	58	65	72	80	87	94	101	109	116	123	130
20	54	62	69	77	84	92	100	107	115	123	130	138

Critical U-values for a one-sided test on the 5 % level

m \ n	9	10	11	12	13	14	15	16	17	18	19	20
1												
2	0	0	0	1	1	1	1	1	2	2	2	2
3	2	3	3	4	4	5	5	6	6	7	7	8
4	4	5	6	7	8	9	10	11	11	12	13	13
5	7	8	9	11	12	13	14	15	17	18	19	20
6	10	11	13	14	16	17	19	21	22	24	25	27
7	12	14	16	18	20	22	24	26	28	30	32	34
8	15	17	19	22	24	26	29	31	34	36	38	41
9	17	20	23	26	28	31	34	37	39	42	45	48
10	20	23	26	29	33	36	39	42	45	48	52	55
11	23	26	30	33	37	40	44	47	51	55	58	62
12	26	29	33	37	41	45	49	53	57	61	65	69
13	28	33	37	41	45	50	54	59	63	67	72	76
14	31	36	40	45	50	55	59	64	67	74	78	83
15	34	39	44	49	54	59	64	70	75	80	85	90
16	37	42	47	53	59	64	70	75	81	86	92	98
17	39	45	51	57	63	67	75	81	87	93	99	105
18	42	48	55	61	67	74	80	86	93	99	106	112
19	45	52	58	65	72	78	85	92	99	106	113	119
20	48	55	62	69	76	83	90	98	105	112	119	127

Critical U-values for a one-sided test on the 2.5 % level

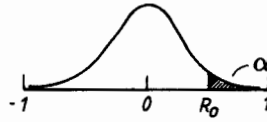


Table A.6  
Critical values of  $R$  in the runs test ( $P = .05$ )

m \ n	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4			2																
5		2	2	3															
6		2	3	3	3														
7		2	3	3	4	4													
8	2	2	3	3	4	4	5												
9	2	2	3	4	4	5	5	6											
10	2	3	3	4	5	5	6	6	6										
11	2	3	3	4	5	5	6	6	7	7									
12	2	3	4	4	5	6	6	7	7	8	8								
13	2	3	4	4	5	6	6	7	8	8	9	9							
14	2	3	4	5	5	6	7	7	8	8	9	9	10						
15	2	3	4	5	6	6	7	8	8	9	9	10	10	11					
16	2	3	4	5	6	6	7	8	8	9	10	10	11	11	11				
17	2	3	4	5	6	7	7	8	9	9	10	10	11	11	12	12			
18	2	3	4	5	6	7	8	8	9	10	10	11	11	12	12	13	13		
19	2	3	4	5	6	7	8	8	9	10	10	11	12	12	13	13	14	14	
20	2	3	4	5	6	7	8	9	9	10	11	11	12	12	13	13	14	14	15

For the two-sample runs test any value of  $R$  which is equal to or less than that shown in the body of the table is significant at the .05 level with direction not predicted, or at the .025 level with direction predicted.

Table A.7



Critical values of Pearson's product moment correlation coefficient

For a two-sided test,  $\alpha$  is twice the value listed at the heading of a column of critical R-values, hence for  $\alpha = .05$  choose the 0.025 column.

n	$\alpha$		
	.05	.025	.005
5	.805	.878	.959
6	.729	.811	.917
7	.669	.754	.875
8	.621	.707	.834
9	.582	.666	.798
10	.549	.632	.765
11	.521	.602	.735
12	.497	.576	.708
13	.476	.553	.684
14	.457	.532	.661
15	.441	.514	.641
16	.426	.497	.623
17	.412	.482	.606
18	.400	.468	.590
19	.389	.456	.575
20	.378	.444	.561
25	.337	.396	.505
30	.306	.361	.463
35	.283	.334	.430
40	.264	.312	.402
50	.235	.279	.361
60	.214	.254	.330
80	.185	.220	.286
100	.165	.196	.256

Table A.8  
 Critical values (p) for Spearman's rank correlation coefficient  
 $P[R_s \leq -r] = P[R_s \geq r] = p$

r	p	r	p	r	p	r	p	r	p	r	p
<u>n = 3</u>		<u>n = 7</u>		<u>n = 8</u>		<u>n = 9</u>		<u>n = 10</u>		<u>n = 10</u>	
1.000	0.167	1.000	0.000	0.690	0.035	0.767	0.011	1.000	0.000	0.491	0.077
0.500	0.500	0.964	0.001	0.667	0.042	0.750	0.013	0.988	0.000	0.479	0.083
		0.929	0.003	0.643	0.048	0.733	0.016	0.976	0.000	0.467	0.089
<u>n = 4</u>		0.893	0.006	0.619	0.057	0.717	0.018	0.964	0.000	0.455	0.096
1.000	0.042	0.857	0.012	0.595	0.066	0.700	0.022	0.952	0.000	0.442	0.102
0.800	0.167	0.821	0.017	0.571	0.076	0.683	0.025	0.939	0.000	0.430	0.109
0.600	0.208	0.786	0.024	0.548	0.085	0.667	0.029	0.927	0.000	0.418	0.116
0.400	0.375	0.750	0.033	0.524	0.098	0.650	0.033	0.915	0.000	0.406	0.124
0.200	0.458	0.714	0.044	0.500	0.108	0.633	0.038	0.903	0.000	0.394	0.132
0.000	0.542	0.679	0.055	0.476	0.122	0.617	0.043	0.891	0.001	0.382	0.139
		0.643	0.069	0.452	0.134	0.600	0.048	0.879	0.001	0.370	0.148
<u>n = 5</u>		0.607	0.083	0.429	0.150	0.583	0.054	0.867	0.001	0.358	0.156
1.000	0.008	0.571	0.100	0.405	0.163	0.567	0.060	0.855	0.001	0.345	0.165
0.900	0.042	0.536	0.118	0.381	0.180	0.550	0.066	0.842	0.002	0.333	0.174
0.800	0.067	0.500	0.133	0.357	0.195	0.533	0.074	0.830	0.002	0.321	0.184
0.700	0.117	0.464	0.151	0.333	0.214	0.517	0.081	0.818	0.003	0.309	0.193
0.600	0.175	0.429	0.177	0.310	0.231	0.500	0.089	0.806	0.004	0.297	0.203
0.500	0.225	0.393	0.198	0.286	0.250	0.483	0.097	0.794	0.004	0.285	0.214
0.400	0.258	0.357	0.222	0.262	0.268	0.467	0.106	0.782	0.005	0.273	0.224
0.300	0.342	0.321	0.249	0.238	0.291	0.450	0.115	0.770	0.007	0.261	0.235
0.200	0.392	0.286	0.278	0.214	0.310	0.433	0.125	0.758	0.008	0.248	0.246
0.100	0.475	0.250	0.297	0.190	0.332	0.417	0.135	0.745	0.009	0.236	0.257
0.000	0.525	0.214	0.331	0.167	0.352	0.400	0.146	0.733	0.010	0.224	0.268
		0.179	0.357	0.143	0.376	0.383	0.156	0.721	0.012	0.212	0.280
<u>n = 6</u>		0.143	0.391	0.119	0.397	0.367	0.168	0.709	0.013	0.200	0.292
1.000	0.001	0.107	0.420	0.095	0.420	0.350	0.179	0.697	0.015	0.188	0.304
0.943	0.008	0.071	0.453	0.071	0.441	0.333	0.193	0.685	0.017	0.176	0.316
0.886	0.017	0.036	0.482	0.048	0.467	0.317	0.205	0.673	0.019	0.164	0.328
0.829	0.029	0.000	0.518	0.024	0.488	0.300	0.218	0.661	0.022	0.152	0.341
0.771	0.051			0.000	0.512	0.283	0.231	0.648	0.025	0.139	0.354
0.714	0.068	<u>n = 8</u>		<u>n = 9</u>		0.267	0.247	0.636	0.027	0.127	0.367
0.657	0.088	1.000	0.000	1.000	0.000	0.250	0.260	0.624	0.030	0.115	0.379
0.600	0.121	0.976	0.000	0.983	0.000	0.233	0.276	0.612	0.033	0.103	0.393
0.543	0.149	0.952	0.001	0.967	0.000	0.217	0.290	0.600	0.037	0.091	0.406
0.486	0.178	0.929	0.001	0.950	0.000	0.200	0.307	0.588	0.040	0.079	0.419
0.429	0.210	0.905	0.002	0.933	0.000	0.183	0.322	0.576	0.044	0.067	0.433
0.371	0.249	0.881	0.004	0.917	0.001	0.167	0.339	0.564	0.048	0.055	0.446
0.314	0.282	0.857	0.005	0.900	0.001	0.150	0.354	0.552	0.052	0.042	0.459
0.257	0.329	0.833	0.008	0.883	0.002	0.133	0.372	0.539	0.057	0.030	0.473
0.200	0.357	0.810	0.011	0.867	0.002	0.117	0.388	0.527	0.062	0.018	0.486
0.143	0.401	0.786	0.014	0.850	0.003	0.100	0.405	0.515	0.067	0.006	0.500
0.086	0.460	0.762	0.018	0.833	0.004	0.083	0.422	0.503	0.072		
0.029	0.500	0.738	0.023	0.817	0.005	0.067	0.440				
		0.714	0.029	0.800	0.007	0.050	0.456				
				0.783	0.009	0.033	0.474				
						0.017	0.491				
						0.000	0.509				

Table A.9  
Table of random digits

94015	46874	32444	48277	59820	96163	64654	25843	41145	42820
74108	88222	88570	74015	25704	91035	01755	14750	48968	38603
62880	87873	95160	59221	22304	90314	72877	17334	39283	04149
11748	12102	80580	41867	17710	59621	06554	07850	73950	79552
17944	05600	60478	03343	25852	58903	57216	39618	49856	99326
66067	42792	95043	52680	46780	56487	09971	59481	37008	22186
54244	91030	45547	70818	59849	96169	61459	21647	87417	17198
30945	57589	31732	57260	47670	07654	46376	25366	94746	49580
69170	37403	86995	90307	94304	71803	26825	05511	12459	91314
08345	88975	35841	85771	08105	59987	87112	21476	14713	71161
27767	43584	85301	88977	29490	69714	73035	41207	74699	09310
13025	14338	54066	15243	47724	66733	47431	43905	32048	56699
80217	26292	98525	24335	24432	24896	43277	58874	11466	16082
10875	62004	90391	61105	57411	06368	53856	30743	08670	84741
54127	57326	26629	19087	24472	88779	30540	27888	61732	75434
60311	42824	37301	42678	45990	43242	17374	52003	70707	70214
49739	71484	92003	98086	76668	73209	59202	11973	02902	33250
78626	51594	16453	94614	39014	97068	83012	09832	25571	77628
66692	13986	99837	00582	81232	44987	09504	96412	90193	79568
44071	25091	97362	97703	76447	42537	98524	97831	65704	09514
41468	85149	49554	17994	14924	39650	95294	00556	70481	06905
94559	37559	49678	53119	70312	05682	66986	34099	74474	20740
41615	70360	64114	58660	90850	64618	80620	51790	11436	38072
50273	93113	41794	88861	24781	89683	55411	85567	77535	99892
41396	80504	90670	08289	40902	05069	95083	06783	28102	57816
25807	24260	71529	78920	72682	07385	90726	57166	98884	08583
06170	97965	88302	98041	21443	41808	68984	83620	89747	98882
60808	54444	74412	81105	01176	28828	36421	16489	18059	51061
80940	44893	10408	36222	80582	71944	92638	40333	67054	16067
19516	90120	46759	71643	13177	55292	21036	82808	77501	97427
49386	54480	23804	23554	21785	41101	91178	10174	29420	90438
06312	88940	15995	69321	47458	64809	98189	81851	29651	84214
60942	00307	11897	92674	40405	68032	96717	54244	10701	41393
92329	98932	78284	46347	71209	92061	39448	93136	25722	08564
77938	63574	31384	51924	85561	29671	58137	17820	22751	36318
38101	77756	11657	12897	95889	57067	47648	13885	70669	93406
39641	69457	91339	22502	92613	89713	11947	56203	19324	20504
84054	40455	99396	63680	67667	60631	59181	96845	38525	11600
47468	03577	67649	63266	24700	71594	14004	23153	69249	05747
43321	31370	28977	23898	76479	68562	62342	07589	08899	05983
64281	61826	18555	64937	13173	33365	78851	16499	87064	13075
66847	70495	32350	02985	86716	38746	28313	77463	55387	72681
72461	33230	21529	53424	92581	02262	78438	66276	18396	73538
21032	91050	13058	16218	12470	56500	15292	76139	59328	52113
95362	67011	06651	16136	01016	00857	55018	56374	35824	71708
49712	97380	10404	55452	34030	60726	75211	10271	36633	68424
58275	61764	97586	54716	50259	46345	87195	46092	26787	60939
59514	11788	68224	23417	73959	76145	30342	40277	11049	72049
15472	50669	48139	26732	46874	37088	73465	09819	58889	35220
12120	86124	51247	44302	60883	52109	21437	36786	49226	77837