UNIVERSIDADE DE LISBOA

INSTITUTO SUPERIOR DE AGRONOMIA

ESTATÍSTICA

Material de Consulta

Indicadores para dados univariados

$x_1, x_2, \cdots, x_n$amostra ordenada

$x_{(1)} \le x_{(2)} \le \cdots \le x_{(n)}$

mediana $\quad \tilde{x} = \begin{cases} x_{(\frac{n+1}{2})} & n \text{ ímpar} \\ \dfrac{x_{(n/2)} + x_{(n/2+1)}}{2} & n \text{ par} \end{cases}$

Quantil de ordem θ $(0 \le \theta < 1)$

$Q^*_\theta = (1-\epsilon)x_{(r)} + \epsilon x_{(r+1)}$ com $1 + (n-1)\theta = r + \epsilon$

$Q_1 = Q^*_{0.25}, \quad Q_3 = Q^*_{0.75}$

barreira inferior $\quad BI = Q_1 - 1.5(Q_3 - Q_1)$

barreira superior $\quad BS = Q_3 + 1.5(Q_3 - Q_1)$

$$s_x^2 = \frac{\sum_{i=1}^n (x_i - \overline{x})^2}{n-1} = \frac{n\sum_{i=1}^n x_i^2 - (\sum_{i=1}^n x_i)^2}{n(n-1)}$$

se $x_i' = a + bx_i$ então $\overline{x'} = a + b\overline{x}, \quad s^2_{x'} = b^2 s^2_x$

regra de Sturges (divisão em classes)

o n. de classes próximo de $1 + \dfrac{\ln n}{\ln 2}$

Indicadores para dados bivariados

$(x_1, y_1), (x_2, y_2), \cdots, (x_n, y_n)$

$$cov(x,y) = \frac{\sum_{i=1}^n (x_i - \overline{x})(y_i - \overline{y})}{n-1} = \frac{n\sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n(n-1)}$$

$r = r_{xy} = \dfrac{cov(x,y)}{s_x s_y}$ se $s_x \neq 0, s_y \neq 0$

se $x_i' = a + bx_i$ e $y_i' = c + dy_i$

$cov(x', y') = bd\, cov(x,y)$

$r_{x'y'} = \begin{cases} r_{xy} & \text{se } bd > 0 \\ -r_{xy} & \text{se } bd < 0 \end{cases}$

Regressão linear simples

$\widehat{y}_i = b_0 + b_1 x_i \quad \widehat{y}_i - \overline{y} = b_1(x_i - \overline{x})$

$y_i = \widehat{y}_i + e_i$

$$\begin{cases} b_1 = \dfrac{cov(x,y)}{s_x^2} = r\dfrac{s_y}{s_x}, & s_x \neq 0 \\ b_0 = \overline{y} - b_1\overline{x} \end{cases}$$

$\sum_{i=1}^n (y_i - \overline{y})^2 = \sum_{i=1}^n (y_i - \hat{y}_i)^2 + \sum_{i=1}^n (\hat{y}_i - \overline{y})^2$

$\Leftrightarrow SQ_T = SQ_E + SQ_R$

coeficiente de determinação

$$R^2 = \frac{s^2_{\hat{y}}}{s^2_y} = \frac{SQ_R}{SQ_T} = \frac{cov^2(x,y)}{s_x^2\, s_y^2} = r^2$$

Probabilidade de acontecimentos

$P(A - B) = P(A \cap \overline{B}) = P(A) - P(A \cap B)$

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$P(\overline{A}|B) = 1 - P(A|B), \quad$ se $P(B) \neq 0$

Parâmetros (de funções) de uma v.a. X

$$E[\varphi(X)] = \begin{cases} \sum_i \varphi(x_i)p_i, & \text{se } X \text{ discreta} \\ \int_{-\infty}^{+\infty} \varphi(x)f(x)dx, & \text{se } X \text{ contínua} \end{cases}$$

$\sigma^2 = Var(X) = E[(X-\mu)^2] = E[X^2] - \mu^2$

$(\mu = E[X])$

$Var(a + bX) = b^2 Var(X)$

Quantil de probabilidade p, χ_p, de uma v.a. X é o menor valor x tal que $F(x) \ge p$ (se X contínua $F(\chi_p) = p$)

Pares aleatórios (X,Y) discretos com f. massa de probabilidade conjunta $P[X = x_i, Y = y_j] = p_{ij}$

$p_{i\cdot} = \sum_j p_{ij} \qquad p_{\cdot j} = \sum_i p_{ij}$

$P[X = x_i | Y = y_j] = \dfrac{p_{ij}}{p_{\cdot j}}$

Parâmetros de funções de um par aleatório (X,Y)

$$E[g(X,Y)] = \begin{cases} \sum_i \sum_j g(x_i, y_j)p_{ij}, & (X,Y) \text{ discreto} \\ \iint_{\mathbb{R}^2} g(x,y)f(x,y)dxdy, & (X,Y) \text{ contínuo} \end{cases}$$

$\sigma_{X,Y} = Cov(X,Y) = E[(X - \mu_X)(Y - \mu_Y)]$

$\qquad = E[XY] - E[X]E[Y]$

$Var(X \pm Y) = Var(X) + Var(Y) \pm 2Cov(X,Y)$

$Cov(a + bX, c + dY) = bdCov(X,Y)$

$\rho = \rho_{X,Y} = \dfrac{\sigma_{X,Y}}{\sigma_X \sigma_Y}$, $\sigma_X \neq 0$, $\sigma_Y \neq 0$

$\rho_{a+bX,c+dY} = \rho_{X,Y}$ se $bd > 0$

Distribuição uniforme discreta

$X \frown \mathcal{UD}(1, 2, \ldots, n)$

$E[X] = \dfrac{n+1}{2}$, $Var[X] = \dfrac{n^2 - 1}{12}$

Distribuição binomial

$X \frown \mathcal{B}(n,p) \Leftrightarrow n - X \frown \mathcal{B}(n,q)$, com $q = 1 - p$

$P(X = x) = \binom{n}{x} p^x q^{n-x}$, $x = 0, \ldots, n$

$E[X] = np$, $Var[X] = npq$

Distribuição de Poisson

$X \frown \mathcal{P}(\lambda)$, $\lambda > 0$

$P(X = x) = \dfrac{e^{-\lambda}\lambda^x}{x!}$, $x = 0, 2, \ldots$

$E[X] = \lambda$, $Var[X] = \lambda$

Aproximações das distribuições

$X \frown H(N,n,k)$ e $\dfrac{N}{n} > 10 \Rightarrow X \sim B(n,p)$, com $p = \dfrac{k}{N}$

$X \frown B(n,p)$, $n \geq 20$ e $p \leq 0.05 \Rightarrow X \sim P(\lambda)$, com $\lambda = np$

$X \frown B(n,p)$, $np > 5$ e $nq > 5 \Rightarrow X \sim \mathcal{N}(\mu,\sigma)$, com $\mu = np$ e $\sigma = \sqrt{npq}$

$X \frown P(\lambda)$ e $\lambda > 12 \Rightarrow X \sim \mathcal{N}(\mu,\sigma)$, com $\mu = \lambda$ e $\sigma = \sqrt{\lambda}$

Teorema Limite Central

Sejam $X_1, \ldots, X_n$ v.a.'s independentes e identicamente distribuidas com valor médio μ e variância σ^2 (finita), $S_n = \sum_{i=1}^n X_i$ e $\bar{X}_n = \sum_{i=1}^n \dfrac{X_i}{n}$, então para n "grande" ($n \geq 30$)

$$\frac{S_n - n\mu}{\sigma\sqrt{n}} \sim \mathcal{N}(0,1) \quad \text{e} \quad \frac{\bar{X}_n - \mu}{\sigma/\sqrt{n}} \sim \mathcal{N}(0,1)$$

Teste de Shapiro Wilk

H_0: X tem distribuição normal

H_1: X não tem distribuição normal

Testes χ^2 de Pearson

$X^2 = \sum_{i=1}^k \dfrac{(\mathcal{O}_i - E_i)^2}{E_i} \sim \chi^2_{(k-1)}$ sob H_0

$X^2 = \sum_{i=1}^a \sum_{j=1}^b \dfrac{(\mathcal{O}_{ij} - E_{ij})^2}{E_{ij}} \sim \chi^2_{(ab-1)}$ sob H_0

$X^2 = \sum_{i=1}^a \sum_{j=1}^b \dfrac{(\mathcal{O}_{ij} - \hat{E}_{ij})^2}{\hat{E}_{ij}} \sim \chi^2_{(a-1)(b-1)}$ sob H_0

Expressões úteis

Combinações de n elementos k a k, $n, k \in \mathbb{N}_0$, $k \leq n$

$C_k^n = \dbinom{n}{k} = \dfrac{n!}{k!(n-k)!}$

Algumas regras de primitivas

Uma primitiva de xe^{-x} é $-e^{-x}(x+1)$

$P(fg) = Fg - P(Fg')$, com $F = Pf$

$P(f'f^\alpha) = \frac{f^{\alpha+1}}{\alpha+1} + C$, com $\alpha \neq -1$

$P(f'e^f) = e^f + C, \qquad P\frac{f'}{f} = \ln|f| + C$

Distribuições em Python (scipy.stats)

Métodos

`pdf(x, ...)`=probability density function at x
$f(x)$ para v.a. contínua

`pmf(k, ...)`=probability mass function at k
$P(X = k)$, se X é v.a. discreta

`cdf(x, ...)`=cumulative distribution function
$F(x) = P(X \leq x)$

`ppf(pr, ...)`=percent point function (inverse of cdf) at pr $\rightarrow$ quantil de probabilidade pr

Distribuições

Binomial (n,p)

`binom.pmf(k, n, p)`
`binom.cdf(x, n, p)`
`binom.ppf(pr, n, p)`

Poisson(λ)

`poisson.pmf(k, mu)`, mu=λ
`poisson.cdf(x, mu)`
`poisson.ppf(pr, mu)`

Normal(μ, σ)

`norm.pdf(x, loc, scale)`, `loc=`μ, `scale=`σ
`norm.cdf(x, loc, scale)`
`norm.ppf(pr, loc, scale)`

Qui-quadrado com n graus de liberdade

`chi2.pdf(x, df)`, `df=`n
`chi2.cdf(x, df)`
`chi2.ppf(pr, df)`

t-Student com n graus de liberdade

`t.pdf(x, df)`, `df=`n
`t.cdf(x, df)`
`t.ppf(pr, df)`

F-Snedecor com (m,n) graus de liberdade

`f.pdf(x, dfn, dfd)`, `dfn=`m, `dfd=`n
`f.cdf(x, dfn, dfd)`
`f.ppf(pr, dfn, dfd)`

Função Distribuição Cumulativa da Binomial

Esta tabela foi criada com base no comando `pbinom` do *software R*, indicando os valores da Função Distribuição Cumulativa duma variável aleatória com distribuição Binomial, $X \cap B(n, p)$, para valores dos parâmetros n indicados na primeira coluna, valores do pâremetro p indicados no topo de cada coluna, e valores da variável x indicados na segunda coluna. No corpo da tabela estão as probabilidades $P[X \leq x]$.

		p									
n	x	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
2	0	0.9025	0.8100	0.7225	0.6400	0.5625	0.4900	0.4225	0.3600	0.3025	0.2500
	1	0.9975	0.9900	0.9775	0.9600	0.9375	0.9100	0.8775	0.8400	0.7975	0.7500
	2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0	0.8574	0.7290	0.6141	0.5120	0.4219	0.3430	0.2746	0.2160	0.1664	0.1250
	1	0.9928	0.9720	0.9392	0.8960	0.8438	0.7840	0.7183	0.6480	0.5748	0.5000
	2	0.9999	0.9990	0.9966	0.9920	0.9844	0.9730	0.9571	0.9360	0.9089	0.8750
	3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0	0.8145	0.6561	0.5220	0.4096	0.3164	0.2401	0.1785	0.1296	0.0915	0.0625
	1	0.9860	0.9477	0.8905	0.8192	0.7383	0.6517	0.5630	0.4752	0.3910	0.3125
	2	0.9995	0.9963	0.9880	0.9728	0.9492	0.9163	0.8735	0.8208	0.7585	0.6875
	3	1.0000	0.9999	0.9995	0.9984	0.9961	0.9919	0.9850	0.9744	0.9590	0.9375
	4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0	0.7738	0.5905	0.4437	0.3277	0.2373	0.1681	0.1160	0.0778	0.0503	0.0312
	1	0.9774	0.9185	0.8352	0.7373	0.6328	0.5282	0.4284	0.3370	0.2562	0.1875
	2	0.9988	0.9914	0.9734	0.9421	0.8965	0.8369	0.7648	0.6826	0.5931	0.5000
	3	1.0000	0.9995	0.9978	0.9933	0.9844	0.9692	0.9460	0.9130	0.8688	0.8125
	4	1.0000	1.0000	0.9999	0.9997	0.9990	0.9976	0.9947	0.9898	0.9815	0.9688
	5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0	0.7351	0.5314	0.3771	0.2621	0.1780	0.1176	0.0754	0.0467	0.0277	0.0156
	1	0.9672	0.8857	0.7765	0.6554	0.5339	0.4202	0.3191	0.2333	0.1636	0.1094
	2	0.9978	0.9842	0.9527	0.9011	0.8306	0.7443	0.6471	0.5443	0.4415	0.3438
	3	0.9999	0.9987	0.9941	0.9830	0.9624	0.9295	0.8826	0.8208	0.7447	0.6562
	4	1.0000	0.9999	0.9996	0.9984	0.9954	0.9891	0.9777	0.9590	0.9308	0.8906
	5	1.0000	1.0000	1.0000	0.9999	0.9998	0.9993	0.9982	0.9959	0.9917	0.9844
	6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	0	0.6983	0.4783	0.3206	0.2097	0.1335	0.0824	0.0490	0.0280	0.0152	0.0078
	1	0.9556	0.8503	0.7166	0.5767	0.4449	0.3294	0.2338	0.1586	0.1024	0.0625
	2	0.9962	0.9743	0.9262	0.8520	0.7564	0.6471	0.5323	0.4199	0.3164	0.2266
	3	0.9998	0.9973	0.9879	0.9667	0.9294	0.8740	0.8002	0.7102	0.6083	0.5000
	4	1.0000	0.9998	0.9988	0.9953	0.9871	0.9712	0.9444	0.9037	0.8471	0.7734
	5	1.0000	1.0000	0.9999	0.9996	0.9987	0.9962	0.9910	0.9812	0.9643	0.9375
	6	1.0000	1.0000	1.0000	1.0000	0.9999	0.9998	0.9994	0.9984	0.9963	0.9922
	7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	0	0.6634	0.4305	0.2725	0.1678	0.1001	0.0576	0.0319	0.0168	0.0084	0.0039
	1	0.9428	0.8131	0.6572	0.5033	0.3671	0.2553	0.1691	0.1064	0.0632	0.0352
	2	0.9942	0.9619	0.8948	0.7969	0.6785	0.5518	0.4278	0.3154	0.2201	0.1445
	3	0.9996	0.9950	0.9786	0.9437	0.8862	0.8059	0.7064	0.5941	0.4770	0.3633
	4	1.0000	0.9996	0.9971	0.9896	0.9727	0.9420	0.8939	0.8263	0.7396	0.6367
	5	1.0000	1.0000	0.9998	0.9988	0.9958	0.9887	0.9747	0.9502	0.9115	0.8555
	6	1.0000	1.0000	1.0000	0.9999	0.9996	0.9987	0.9964	0.9915	0.9819	0.9648
	7	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9998	0.9993	0.9983	0.9961
	8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

		p									
n	x	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
9	0	0.6302	0.3874	0.2316	0.1342	0.0751	0.0404	0.0207	0.0101	0.0046	0.0020
	1	0.9288	0.7748	0.5995	0.4362	0.3003	0.1960	0.1211	0.0705	0.0385	0.0195
	2	0.9916	0.9470	0.8591	0.7382	0.6007	0.4628	0.3373	0.2318	0.1495	0.0898
	3	0.9994	0.9917	0.9661	0.9144	0.8343	0.7297	0.6089	0.4826	0.3614	0.2539
	4	1.0000	0.9991	0.9944	0.9804	0.9511	0.9012	0.8283	0.7334	0.6214	0.5000
	5	1.0000	0.9999	0.9994	0.9969	0.9900	0.9747	0.9464	0.9006	0.8342	0.7461
	6	1.0000	1.0000	1.0000	0.9997	0.9987	0.9957	0.9888	0.9750	0.9502	0.9102
	7	1.0000	1.0000	1.0000	1.0000	0.9999	0.9996	0.9986	0.9962	0.9909	0.9805
	8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9992	0.9980
	9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	0	0.5987	0.3487	0.1969	0.1074	0.0563	0.0282	0.0135	0.0060	0.0025	0.0010
	1	0.9139	0.7361	0.5443	0.3758	0.2440	0.1493	0.0860	0.0464	0.0233	0.0107
	2	0.9885	0.9298	0.8202	0.6778	0.5256	0.3828	0.2616	0.1673	0.0996	0.0547
	3	0.9990	0.9872	0.9500	0.8791	0.7759	0.6496	0.5138	0.3823	0.2660	0.1719
	4	0.9999	0.9984	0.9901	0.9672	0.9219	0.8497	0.7515	0.6331	0.5044	0.3770
	5	1.0000	0.9999	0.9986	0.9936	0.9803	0.9527	0.9051	0.8338	0.7384	0.6230
	6	1.0000	1.0000	0.9999	0.9991	0.9965	0.9894	0.9740	0.9452	0.8980	0.8281
	7	1.0000	1.0000	1.0000	0.9999	0.9996	0.9984	0.9952	0.9877	0.9726	0.9453
	8	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9995	0.9983	0.9955	0.9893
	9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9990
	10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	0	0.5688	0.3138	0.1673	0.0859	0.0422	0.0198	0.0088	0.0036	0.0014	0.0005
	1	0.8981	0.6974	0.4922	0.3221	0.1971	0.1130	0.0606	0.0302	0.0139	0.0059
	2	0.9848	0.9104	0.7788	0.6174	0.4552	0.3127	0.2001	0.1189	0.0652	0.0327
	3	0.9984	0.9815	0.9306	0.8389	0.7133	0.5696	0.4256	0.2963	0.1911	0.1133
	4	0.9999	0.9972	0.9841	0.9496	0.8854	0.7897	0.6683	0.5328	0.3971	0.2744
	5	1.0000	0.9997	0.9973	0.9883	0.9657	0.9218	0.8513	0.7535	0.6331	0.5000
	6	1.0000	1.0000	0.9997	0.9980	0.9924	0.9784	0.9499	0.9006	0.8262	0.7256
	7	1.0000	1.0000	1.0000	0.9998	0.9988	0.9957	0.9878	0.9707	0.9390	0.8867
	8	1.0000	1.0000	1.0000	1.0000	0.9999	0.9994	0.9980	0.9941	0.9852	0.9673
	9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9998	0.9993	0.9978	0.9941
	10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9998	0.9995
	11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	0	0.5404	0.2824	0.1422	0.0687	0.0317	0.0138	0.0057	0.0022	0.0008	0.0002
	1	0.8816	0.6590	0.4435	0.2749	0.1584	0.0850	0.0424	0.0196	0.0083	0.0032
	2	0.9804	0.8891	0.7358	0.5583	0.3907	0.2528	0.1513	0.0834	0.0421	0.0193
	3	0.9978	0.9744	0.9078	0.7946	0.6488	0.4925	0.3467	0.2253	0.1345	0.0730
	4	0.9998	0.9957	0.9761	0.9274	0.8424	0.7237	0.5833	0.4382	0.3044	0.1938
	5	1.0000	0.9995	0.9954	0.9806	0.9456	0.8822	0.7873	0.6652	0.5269	0.3872
	6	1.0000	0.9999	0.9993	0.9961	0.9857	0.9614	0.9154	0.8418	0.7393	0.6128
	7	1.0000	1.0000	0.9999	0.9994	0.9972	0.9905	0.9745	0.9427	0.8883	0.8062
	8	1.0000	1.0000	1.0000	0.9999	0.9996	0.9983	0.9944	0.9847	0.9644	0.9270
	9	1.0000	1.0000	1.0000	1.0000	1.0000	0.9998	0.9992	0.9972	0.9921	0.9807
	10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9989	0.9968
	11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9998
	12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	0	0.5133	0.2542	0.1209	0.0550	0.0238	0.0097	0.0037	0.0013	0.0004	0.0001
	1	0.8646	0.6213	0.3983	0.2336	0.1267	0.0637	0.0296	0.0126	0.0049	0.0017
	2	0.9755	0.8661	0.6920	0.5017	0.3326	0.2025	0.1132	0.0579	0.0269	0.0112
	3	0.9969	0.9658	0.8820	0.7473	0.5843	0.4206	0.2783	0.1686	0.0929	0.0461
	4	0.9997	0.9935	0.9658	0.9009	0.7940	0.6543	0.5005	0.3530	0.2279	0.1334
	5	1.0000	0.9991	0.9925	0.9700	0.9198	0.8346	0.7159	0.5744	0.4268	0.2905
	6	1.0000	0.9999	0.9987	0.9930	0.9757	0.9376	0.8705	0.7712	0.6437	0.5000

		p									
n	x	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
	7	1.0000	1.0000	0.9998	0.9988	0.9944	0.9818	0.9538	0.9023	0.8212	0.7095
	8	1.0000	1.0000	1.0000	0.9998	0.9990	0.9960	0.9874	0.9679	0.9302	0.8666
	9	1.0000	1.0000	1.0000	1.0000	0.9999	0.9993	0.9975	0.9922	0.9797	0.9539
	10	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9987	0.9959	0.9888
	11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9995	0.9983
	12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999
	13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	0	0.4877	0.2288	0.1028	0.0440	0.0178	0.0068	0.0024	0.0008	0.0002	0.0001
	1	0.8470	0.5846	0.3567	0.1979	0.1010	0.0475	0.0205	0.0081	0.0029	0.0009
	2	0.9699	0.8416	0.6479	0.4481	0.2811	0.1608	0.0839	0.0398	0.0170	0.0065
	3	0.9958	0.9559	0.8535	0.6982	0.5213	0.3552	0.2205	0.1243	0.0632	0.0287
	4	0.9996	0.9908	0.9533	0.8702	0.7415	0.5842	0.4227	0.2793	0.1672	0.0898
	5	1.0000	0.9985	0.9885	0.9561	0.8883	0.7805	0.6405	0.4859	0.3373	0.2120
	6	1.0000	0.9998	0.9978	0.9884	0.9617	0.9067	0.8164	0.6925	0.5461	0.3953
	7	1.0000	1.0000	0.9997	0.9976	0.9897	0.9685	0.9247	0.8499	0.7414	0.6047
	8	1.0000	1.0000	1.0000	0.9996	0.9978	0.9917	0.9757	0.9417	0.8811	0.7880
	9	1.0000	1.0000	1.0000	1.0000	0.9997	0.9983	0.9940	0.9825	0.9574	0.9102
	10	1.0000	1.0000	1.0000	1.0000	1.0000	0.9998	0.9989	0.9961	0.9886	0.9713
	11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9994	0.9978	0.9935
	12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9991
	13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999
	14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	0	0.4633	0.2059	0.0874	0.0352	0.0134	0.0047	0.0016	0.0005	0.0001	0.0000
	1	0.8290	0.5490	0.3186	0.1671	0.0802	0.0353	0.0142	0.0052	0.0017	0.0005
	2	0.9638	0.8159	0.6042	0.3980	0.2361	0.1268	0.0617	0.0271	0.0107	0.0037
	3	0.9945	0.9444	0.8227	0.6482	0.4613	0.2969	0.1727	0.0905	0.0424	0.0176
	4	0.9994	0.9873	0.9383	0.8358	0.6865	0.5155	0.3519	0.2173	0.1204	0.0592
	5	0.9999	0.9978	0.9832	0.9389	0.8516	0.7216	0.5643	0.4032	0.2608	0.1509
	6	1.0000	0.9997	0.9964	0.9819	0.9434	0.8689	0.7548	0.6098	0.4522	0.3036
	7	1.0000	1.0000	0.9994	0.9958	0.9827	0.9500	0.8868	0.7869	0.6535	0.5000
	8	1.0000	1.0000	0.9999	0.9992	0.9958	0.9848	0.9578	0.9050	0.8182	0.6964
	9	1.0000	1.0000	1.0000	0.9999	0.9992	0.9963	0.9876	0.9662	0.9231	0.8491
	10	1.0000	1.0000	1.0000	1.0000	0.9999	0.9993	0.9972	0.9907	0.9745	0.9408
	11	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9995	0.9981	0.9937	0.9824
	12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9989	0.9963
	13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9995
	14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
16	0	0.4401	0.1853	0.0743	0.0281	0.0100	0.0033	0.0010	0.0003	0.0001	0.0000
	1	0.8108	0.5147	0.2839	0.1407	0.0635	0.0261	0.0098	0.0033	0.0010	0.0003
	2	0.9571	0.7892	0.5614	0.3518	0.1971	0.0994	0.0451	0.0183	0.0066	0.0021
	3	0.9930	0.9316	0.7899	0.5981	0.4050	0.2459	0.1339	0.0651	0.0281	0.0106
	4	0.9991	0.9830	0.9209	0.7982	0.6302	0.4499	0.2892	0.1666	0.0853	0.0384
	5	0.9999	0.9967	0.9765	0.9183	0.8103	0.6598	0.4900	0.3288	0.1976	0.1051
	6	1.0000	0.9995	0.9944	0.9733	0.9204	0.8247	0.6881	0.5272	0.3660	0.2272
	7	1.0000	0.9999	0.9989	0.9930	0.9729	0.9256	0.8406	0.7161	0.5629	0.4018
	8	1.0000	1.0000	0.9998	0.9985	0.9925	0.9743	0.9329	0.8577	0.7441	0.5982
	9	1.0000	1.0000	1.0000	0.9998	0.9984	0.9929	0.9771	0.9417	0.8759	0.7728
	10	1.0000	1.0000	1.0000	1.0000	0.9997	0.9984	0.9938	0.9809	0.9514	0.8949
	11	1.0000	1.0000	1.0000	1.0000	1.0000	0.9997	0.9987	0.9951	0.9851	0.9616
	12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9998	0.9991	0.9965	0.9894
	13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9994	0.9979
	14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997
	15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

		p									
n	x	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
	16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
17	0	0.4181	0.1668	0.0631	0.0225	0.0075	0.0023	0.0007	0.0002	0.0000	0.0000
	1	0.7922	0.4818	0.2525	0.1182	0.0501	0.0193	0.0067	0.0021	0.0006	0.0001
	2	0.9497	0.7618	0.5198	0.3096	0.1637	0.0774	0.0327	0.0123	0.0041	0.0012
	3	0.9912	0.9174	0.7556	0.5489	0.3530	0.2019	0.1028	0.0464	0.0184	0.0064
	4	0.9988	0.9779	0.9013	0.7582	0.5739	0.3887	0.2348	0.1260	0.0596	0.0245
	5	0.9999	0.9953	0.9681	0.8943	0.7653	0.5968	0.4197	0.2639	0.1471	0.0717
	6	1.0000	0.9992	0.9917	0.9623	0.8929	0.7752	0.6188	0.4478	0.2902	0.1662
	7	1.0000	0.9999	0.9983	0.9891	0.9598	0.8954	0.7872	0.6405	0.4743	0.3145
	8	1.0000	1.0000	0.9997	0.9974	0.9876	0.9597	0.9006	0.8011	0.6626	0.5000
	9	1.0000	1.0000	1.0000	0.9995	0.9969	0.9873	0.9617	0.9081	0.8166	0.6855
	10	1.0000	1.0000	1.0000	0.9999	0.9994	0.9968	0.9880	0.9652	0.9174	0.8338
	11	1.0000	1.0000	1.0000	1.0000	0.9999	0.9993	0.9970	0.9894	0.9699	0.9283
	12	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9994	0.9975	0.9914	0.9755
	13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9995	0.9981	0.9936
	14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9988
	15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999
	16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	17	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	0	0.3972	0.1501	0.0536	0.0180	0.0056	0.0016	0.0004	0.0001	0.0000	0.0000
	1	0.7735	0.4503	0.2241	0.0991	0.0395	0.0142	0.0046	0.0013	0.0003	0.0001
	2	0.9419	0.7338	0.4797	0.2713	0.1353	0.0600	0.0236	0.0082	0.0025	0.0007
	3	0.9891	0.9018	0.7202	0.5010	0.3057	0.1646	0.0783	0.0328	0.0120	0.0038
	4	0.9985	0.9718	0.8794	0.7164	0.5187	0.3327	0.1886	0.0942	0.0411	0.0154
	5	0.9998	0.9936	0.9581	0.8671	0.7175	0.5344	0.3550	0.2088	0.1077	0.0481
	6	1.0000	0.9988	0.9882	0.9487	0.8610	0.7217	0.5491	0.3743	0.2258	0.1189
	7	1.0000	0.9998	0.9973	0.9837	0.9431	0.8593	0.7283	0.5634	0.3915	0.2403
	8	1.0000	1.0000	0.9995	0.9957	0.9807	0.9404	0.8609	0.7368	0.5778	0.4073
	9	1.0000	1.0000	0.9999	0.9991	0.9946	0.9790	0.9403	0.8653	0.7473	0.5927
	10	1.0000	1.0000	1.0000	0.9998	0.9988	0.9939	0.9788	0.9424	0.8720	0.7597
	11	1.0000	1.0000	1.0000	1.0000	0.9998	0.9986	0.9938	0.9797	0.9463	0.8811
	12	1.0000	1.0000	1.0000	1.0000	1.0000	0.9997	0.9986	0.9942	0.9817	0.9519
	13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9997	0.9987	0.9951	0.9846
	14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9998	0.9990	0.9962
	15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9993
	16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999
	17	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
19	0	0.3774	0.1351	0.0456	0.0144	0.0042	0.0011	0.0003	0.0001	0.0000	0.0000
	1	0.7547	0.4203	0.1985	0.0829	0.0310	0.0104	0.0031	0.0008	0.0002	0.0000
	2	0.9335	0.7054	0.4413	0.2369	0.1113	0.0462	0.0170	0.0055	0.0015	0.0004
	3	0.9868	0.8850	0.6841	0.4551	0.2631	0.1332	0.0591	0.0230	0.0077	0.0022
	4	0.9980	0.9648	0.8556	0.6733	0.4654	0.2822	0.1500	0.0696	0.0280	0.0096
	5	0.9998	0.9914	0.9463	0.8369	0.6678	0.4739	0.2968	0.1629	0.0777	0.0318
	6	1.0000	0.9983	0.9837	0.9324	0.8251	0.6655	0.4812	0.3081	0.1727	0.0835
	7	1.0000	0.9997	0.9959	0.9767	0.9225	0.8180	0.6656	0.4878	0.3169	0.1796
	8	1.0000	1.0000	0.9992	0.9933	0.9713	0.9161	0.8145	0.6675	0.4940	0.3238
	9	1.0000	1.0000	0.9999	0.9984	0.9911	0.9674	0.9125	0.8139	0.6710	0.5000
	10	1.0000	1.0000	1.0000	0.9997	0.9977	0.9895	0.9653	0.9115	0.8159	0.6762
	11	1.0000	1.0000	1.0000	1.0000	0.9995	0.9972	0.9886	0.9648	0.9129	0.8204
	12	1.0000	1.0000	1.0000	1.0000	0.9999	0.9994	0.9969	0.9884	0.9658	0.9165
	13	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9993	0.9969	0.9891	0.9682
	14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9994	0.9972	0.9904
	15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9995	0.9978

		p									
n	x	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
	16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9996
	17	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	19	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20	0	0.3585	0.1216	0.0388	0.0115	0.0032	0.0008	0.0002	0.0000	0.0000	0.0000
	1	0.7358	0.3917	0.1756	0.0692	0.0243	0.0076	0.0021	0.0005	0.0001	0.0000
	2	0.9245	0.6769	0.4049	0.2061	0.0913	0.0355	0.0121	0.0036	0.0009	0.0002
	3	0.9841	0.8670	0.6477	0.4114	0.2252	0.1071	0.0444	0.0160	0.0049	0.0013
	4	0.9974	0.9568	0.8298	0.6296	0.4148	0.2375	0.1182	0.0510	0.0189	0.0059
	5	0.9997	0.9887	0.9327	0.8042	0.6172	0.4164	0.2454	0.1256	0.0553	0.0207
	6	1.0000	0.9976	0.9781	0.9133	0.7858	0.6080	0.4166	0.2500	0.1299	0.0577
	7	1.0000	0.9996	0.9941	0.9679	0.8982	0.7723	0.6010	0.4159	0.2520	0.1316
	8	1.0000	0.9999	0.9987	0.9900	0.9591	0.8867	0.7624	0.5956	0.4143	0.2517
	9	1.0000	1.0000	0.9998	0.9974	0.9861	0.9520	0.8782	0.7553	0.5914	0.4119
	10	1.0000	1.0000	1.0000	0.9994	0.9961	0.9829	0.9468	0.8725	0.7507	0.5881
	11	1.0000	1.0000	1.0000	0.9999	0.9991	0.9949	0.9804	0.9435	0.8692	0.7483
	12	1.0000	1.0000	1.0000	1.0000	0.9998	0.9987	0.9940	0.9790	0.9420	0.8684
	13	1.0000	1.0000	1.0000	1.0000	1.0000	0.9997	0.9985	0.9935	0.9786	0.9423
	14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9997	0.9984	0.9936	0.9793
	15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9997	0.9985	0.9941
	16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9997	0.9987
	17	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9998
	18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	19	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Função Distribuição Cumulativa da Poisson

Esta tabela foi criada com base no comando `ppois` do *software R*, indicando os valores da Função Distribuição Cumulativa duma variável aleatória com distribuição Poisson, $X \cap P(\lambda)$, para valores do parâmetro λ indicados no topo de cada coluna, e valores da variável x indicados no início de cada linha. No corpo da tabela estão as probabilidades $P[X \leq x]$.

	$\lambda = E[X]$									
x	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0	0.905	0.819	0.741	0.670	0.607	0.549	0.497	0.449	0.407	0.368
1	0.995	0.982	0.963	0.938	0.910	0.878	0.844	0.809	0.772	0.736
2	1.000	0.999	0.996	0.992	0.986	0.977	0.966	0.953	0.937	0.920
3	1.000	1.000	1.000	0.999	0.998	0.997	0.994	0.991	0.987	0.981
4	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.998	0.996
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

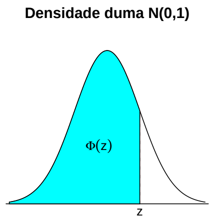
	$\lambda = E[X]$									
x	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2
0	0.333	0.301	0.273	0.247	0.223	0.202	0.183	0.165	0.150	0.135
1	0.699	0.663	0.627	0.592	0.558	0.525	0.493	0.463	0.434	0.406
2	0.900	0.879	0.857	0.833	0.809	0.783	0.757	0.731	0.704	0.677
3	0.974	0.966	0.957	0.946	0.934	0.921	0.907	0.891	0.875	0.857
4	0.995	0.992	0.989	0.986	0.981	0.976	0.970	0.964	0.956	0.947
5	0.999	0.998	0.998	0.997	0.996	0.994	0.992	0.990	0.987	0.983
6	1.000	1.000	1.000	0.999	0.999	0.999	0.998	0.997	0.997	0.995
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.999
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	$\lambda = E[X]$									
x	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
0	0.111	0.091	0.074	0.061	0.050	0.041	0.033	0.027	0.022	0.018
1	0.355	0.308	0.267	0.231	0.199	0.171	0.147	0.126	0.107	0.092
2	0.623	0.570	0.518	0.469	0.423	0.380	0.340	0.303	0.269	0.238
3	0.819	0.779	0.736	0.692	0.647	0.603	0.558	0.515	0.473	0.433
4	0.928	0.904	0.877	0.848	0.815	0.781	0.744	0.706	0.668	0.629
5	0.975	0.964	0.951	0.935	0.916	0.895	0.871	0.844	0.816	0.785
6	0.993	0.988	0.983	0.976	0.966	0.955	0.942	0.927	0.909	0.889
7	0.998	0.997	0.995	0.992	0.988	0.983	0.977	0.969	0.960	0.949
8	1.000	0.999	0.999	0.998	0.996	0.994	0.992	0.988	0.984	0.979
9	1.000	1.000	1.000	0.999	0.999	0.998	0.997	0.996	0.994	0.992
10	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.998	0.997
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	$\lambda = E[X]$									
x	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
0	0.015	0.012	0.010	0.008	0.007	0.006	0.005	0.004	0.003	0.002
1	0.078	0.066	0.056	0.048	0.040	0.034	0.029	0.024	0.021	0.017
2	0.210	0.185	0.163	0.143	0.125	0.109	0.095	0.082	0.072	0.062
3	0.395	0.359	0.326	0.294	0.265	0.238	0.213	0.191	0.170	0.151
4	0.590	0.551	0.513	0.476	0.440	0.406	0.373	0.342	0.313	0.285
5	0.753	0.720	0.686	0.651	0.616	0.581	0.546	0.512	0.478	0.446
6	0.867	0.844	0.818	0.791	0.762	0.732	0.702	0.670	0.638	0.606
7	0.936	0.921	0.905	0.887	0.867	0.845	0.822	0.797	0.771	0.744
8	0.972	0.964	0.955	0.944	0.932	0.918	0.903	0.886	0.867	0.847
9	0.989	0.985	0.980	0.975	0.968	0.960	0.951	0.941	0.929	0.916
10	0.996	0.994	0.992	0.990	0.986	0.982	0.977	0.972	0.965	0.957
11	0.999	0.998	0.997	0.996	0.995	0.993	0.990	0.988	0.984	0.980
12	1.000	0.999	0.999	0.999	0.998	0.997	0.996	0.995	0.993	0.991
13	1.000	1.000	1.000	1.000	0.999	0.999	0.999	0.998	0.997	0.996
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.999
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999
16	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	$\lambda = E[X]$									
x	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10	11	12
0	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.011	0.007	0.005	0.003	0.002	0.001	0.001	0.000	0.000	0.000
2	0.043	0.030	0.020	0.014	0.009	0.006	0.004	0.003	0.001	0.001
3	0.112	0.082	0.059	0.042	0.030	0.021	0.015	0.010	0.005	0.002
4	0.224	0.173	0.132	0.100	0.074	0.055	0.040	0.029	0.015	0.008
5	0.369	0.301	0.241	0.191	0.150	0.116	0.089	0.067	0.038	0.020
6	0.527	0.450	0.378	0.313	0.256	0.207	0.165	0.130	0.079	0.046
7	0.673	0.599	0.525	0.453	0.386	0.324	0.269	0.220	0.143	0.090
8	0.792	0.729	0.662	0.593	0.523	0.456	0.392	0.333	0.232	0.155
9	0.877	0.830	0.776	0.717	0.653	0.587	0.522	0.458	0.341	0.242
10	0.933	0.901	0.862	0.816	0.763	0.706	0.645	0.583	0.460	0.347
11	0.966	0.947	0.921	0.888	0.849	0.803	0.752	0.697	0.579	0.462
12	0.984	0.973	0.957	0.936	0.909	0.876	0.836	0.792	0.689	0.576
13	0.993	0.987	0.978	0.966	0.949	0.926	0.898	0.864	0.781	0.682
14	0.997	0.994	0.990	0.983	0.973	0.959	0.940	0.917	0.854	0.772
15	0.999	0.998	0.995	0.992	0.986	0.978	0.967	0.951	0.907	0.844
16	1.000	0.999	0.998	0.996	0.993	0.989	0.982	0.973	0.944	0.899
17	1.000	1.000	0.999	0.998	0.997	0.995	0.991	0.986	0.968	0.937
18	1.000	1.000	1.000	0.999	0.999	0.998	0.996	0.993	0.982	0.963
19	1.000	1.000	1.000	1.000	0.999	0.999	0.998	0.997	0.991	0.979
20	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.998	0.995	0.988
21	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.998	0.994
22	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.997
23	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999

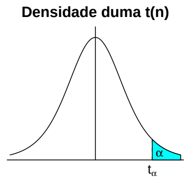
Função Distribuição Cumulativa da Normal Reduzida



Esta tabela foi criada com base no comando `pnorm` do *software R*, indicando os valores da Função Distribuição Cumulativa duma $\mathcal{N}(0,1)$, para valores positivos da variável. No corpo da tabela estão as probabilidades $\Phi(z) = P[Z \le z]$, onde z é o valor da variável que se obtem somando o número (com uma casa decimal) que está no princípio da linha com o número (de duas casas decimais) que está no topo da coluna. **Nota:** $\Phi(-z) = 1 - \Phi(z)$.

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.50000	0.50399	0.50798	0.51197	0.51595	0.51994	0.52392	0.52790	0.53188	0.53586
0.1	0.53983	0.54380	0.54776	0.55172	0.55567	0.55962	0.56356	0.56749	0.57142	0.57535
0.2	0.57926	0.58317	0.58706	0.59095	0.59483	0.59871	0.60257	0.60642	0.61026	0.61409
0.3	0.61791	0.62172	0.62552	0.62930	0.63307	0.63683	0.64058	0.64431	0.64803	0.65173
0.4	0.65542	0.65910	0.66276	0.66640	0.67003	0.67364	0.67724	0.68082	0.68439	0.68793
0.5	0.69146	0.69497	0.69847	0.70194	0.70540	0.70884	0.71226	0.71566	0.71904	0.72240
0.6	0.72575	0.72907	0.73237	0.73565	0.73891	0.74215	0.74537	0.74857	0.75175	0.75490
0.7	0.75804	0.76115	0.76424	0.76730	0.77035	0.77337	0.77637	0.77935	0.78230	0.78524
0.8	0.78814	0.79103	0.79389	0.79673	0.79955	0.80234	0.80511	0.80785	0.81057	0.81327
0.9	0.81594	0.81859	0.82121	0.82381	0.82639	0.82894	0.83147	0.83398	0.83646	0.83891
1.0	0.84134	0.84375	0.84614	0.84849	0.85083	0.85314	0.85543	0.85769	0.85993	0.86214
1.1	0.86433	0.86650	0.86864	0.87076	0.87286	0.87493	0.87698	0.87900	0.88100	0.88298
1.2	0.88493	0.88686	0.88877	0.89065	0.89251	0.89435	0.89617	0.89796	0.89973	0.90147
1.3	0.90320	0.90490	0.90658	0.90824	0.90988	0.91149	0.91309	0.91466	0.91621	0.91774
1.4	0.91924	0.92073	0.92220	0.92364	0.92507	0.92647	0.92785	0.92922	0.93056	0.93189
1.5	0.93319	0.93448	0.93574	0.93699	0.93822	0.93943	0.94062	0.94179	0.94295	0.94408
1.6	0.94520	0.94630	0.94738	0.94845	0.94950	0.95053	0.95154	0.95254	0.95352	0.95449
1.7	0.95543	0.95637	0.95728	0.95818	0.95907	0.95994	0.96080	0.96164	0.96246	0.96327
1.8	0.96407	0.96485	0.96562	0.96638	0.96712	0.96784	0.96856	0.96926	0.96995	0.97062
1.9	0.97128	0.97193	0.97257	0.97320	0.97381	0.97441	0.97500	0.97558	0.97615	0.97670
2.0	0.97725	0.97778	0.97831	0.97882	0.97932	0.97982	0.98030	0.98077	0.98124	0.98169
2.1	0.98214	0.98257	0.98300	0.98341	0.98382	0.98422	0.98461	0.98500	0.98537	0.98574
2.2	0.98610	0.98645	0.98679	0.98713	0.98745	0.98778	0.98809	0.98840	0.98870	0.98899
2.3	0.98928	0.98956	0.98983	0.99010	0.99036	0.99061	0.99086	0.99111	0.99134	0.99158
2.4	0.99180	0.99202	0.99224	0.99245	0.99266	0.99286	0.99305	0.99324	0.99343	0.99361
2.5	0.99379	0.99396	0.99413	0.99430	0.99446	0.99461	0.99477	0.99492	0.99506	0.99520
2.6	0.99534	0.99547	0.99560	0.99573	0.99585	0.99598	0.99609	0.99621	0.99632	0.99643
2.7	0.99653	0.99664	0.99674	0.99683	0.99693	0.99702	0.99711	0.99720	0.99728	0.99736
2.8	0.99744	0.99752	0.99760	0.99767	0.99774	0.99781	0.99788	0.99795	0.99801	0.99807
2.9	0.99813	0.99819	0.99825	0.99831	0.99836	0.99841	0.99846	0.99851	0.99856	0.99861
3.0	0.99865	0.99869	0.99874	0.99878	0.99882	0.99886	0.99889	0.99893	0.99896	0.99900
3.1	0.99903	0.99906	0.99910	0.99913	0.99916	0.99918	0.99921	0.99924	0.99926	0.99929
3.2	0.99931	0.99934	0.99936	0.99938	0.99940	0.99942	0.99944	0.99946	0.99948	0.99950
3.3	0.99952	0.99953	0.99955	0.99957	0.99958	0.99960	0.99961	0.99962	0.99964	0.99965
3.4	0.99966	0.99968	0.99969	0.99970	0.99971	0.99972	0.99973	0.99974	0.99975	0.99976
3.5	0.99977	0.99978	0.99978	0.99979	0.99980	0.99981	0.99981	0.99982	0.99983	0.99983
3.6	0.99984	0.99985	0.99985	0.99986	0.99986	0.99987	0.99987	0.99988	0.99988	0.99989
3.7	0.99989	0.99990	0.99990	0.99990	0.99991	0.99991	0.99992	0.99992	0.99992	0.99992
3.8	0.99993	0.99993	0.99993	0.99994	0.99994	0.99994	0.99994	0.99995	0.99995	0.99995
3.9	0.99995	0.99995	0.99996	0.99996	0.99996	0.99996	0.99996	0.99996	0.99997	0.99997

Valores percentuais da distribuição t-Student



Esta tabela foi criada com base no comando `qt` do *software R*, indicando os quantis de ordem $1 - \alpha$ associados a variáveis aleatórias com distribuição t-Student, $X \cap t_{(n)}$, para valores do parâmetro n indicados no início de cada linha, e valores de α indicados no topo de cada coluna. No corpo da tabela estão os valores de t_α tais que $P[X > t_\alpha] = \alpha$.

	α							
n	0.4	0.25	0.1	0.05	0.025	0.01	0.005	0.001
1	0.32492	1.00000	3.07768	6.31375	12.70620	31.82052	63.65674	318.30884
2	0.28868	0.81650	1.88562	2.91999	4.30265	6.96456	9.92484	22.32712
3	0.27667	0.76489	1.63774	2.35336	3.18245	4.54070	5.84091	10.21453
4	0.27072	0.74070	1.53321	2.13185	2.77645	3.74695	4.60409	7.17318
5	0.26718	0.72669	1.47588	2.01505	2.57058	3.36493	4.03214	5.89343
6	0.26483	0.71756	1.43976	1.94318	2.44691	3.14267	3.70743	5.20763
7	0.26317	0.71114	1.41492	1.89458	2.36462	2.99795	3.49948	4.78529
8	0.26192	0.70639	1.39682	1.85955	2.30600	2.89646	3.35539	4.50079
9	0.26096	0.70272	1.38303	1.83311	2.26216	2.82144	3.24984	4.29681
10	0.26018	0.69981	1.37218	1.81246	2.22814	2.76377	3.16927	4.14370
11	0.25956	0.69745	1.36343	1.79588	2.20099	2.71808	3.10581	4.02470
12	0.25903	0.69548	1.35622	1.78229	2.17881	2.68100	3.05454	3.92963
13	0.25859	0.69383	1.35017	1.77093	2.16037	2.65031	3.01228	3.85198
14	0.25821	0.69242	1.34503	1.76131	2.14479	2.62449	2.97684	3.78739
15	0.25789	0.69120	1.34061	1.75305	2.13145	2.60248	2.94671	3.73283
16	0.25760	0.69013	1.33676	1.74588	2.11991	2.58349	2.92078	3.68615
17	0.25735	0.68920	1.33338	1.73961	2.10982	2.56693	2.89823	3.64577
18	0.25712	0.68836	1.33039	1.73406	2.10092	2.55238	2.87844	3.61048
19	0.25692	0.68762	1.32773	1.72913	2.09302	2.53948	2.86093	3.57940
20	0.25674	0.68695	1.32534	1.72472	2.08596	2.52798	2.84534	3.55181
21	0.25658	0.68635	1.32319	1.72074	2.07961	2.51765	2.83136	3.52715
22	0.25643	0.68581	1.32124	1.71714	2.07387	2.50832	2.81876	3.50499
23	0.25630	0.68531	1.31946	1.71387	2.06866	2.49987	2.80734	3.48496
24	0.25617	0.68485	1.31784	1.71088	2.06390	2.49216	2.79694	3.46678
25	0.25606	0.68443	1.31635	1.70814	2.05954	2.48511	2.78744	3.45019
26	0.25595	0.68404	1.31497	1.70562	2.05553	2.47863	2.77871	3.43500
27	0.25586	0.68368	1.31370	1.70329	2.05183	2.47266	2.77068	3.42103
28	0.25577	0.68335	1.31253	1.70113	2.04841	2.46714	2.76326	3.40816
29	0.25568	0.68304	1.31143	1.69913	2.04523	2.46202	2.75639	3.39624
30	0.25561	0.68276	1.31042	1.69726	2.04227	2.45726	2.75000	3.38518
40	0.25504	0.68067	1.30308	1.68385	2.02108	2.42326	2.70446	3.30688
50	0.25470	0.67943	1.29871	1.67591	2.00856	2.40327	2.67779	3.26141
60	0.25447	0.67860	1.29582	1.67065	2.00030	2.39012	2.66028	3.23171
70	0.25431	0.67801	1.29376	1.66691	1.99444	2.38081	2.64790	3.21079
80	0.25419	0.67757	1.29222	1.66412	1.99006	2.37387	2.63869	3.19526
90	0.25410	0.67723	1.29103	1.66196	1.98667	2.36850	2.63157	3.18327
100	0.25402	0.67695	1.29007	1.66023	1.98397	2.36422	2.62589	3.17374
110	0.25396	0.67673	1.28930	1.65882	1.98177	2.36073	2.62126	3.16598
120	0.25391	0.67654	1.28865	1.65765	1.97993	2.35782	2.61742	3.15954
∞	0.25341	0.67474	1.28240	1.64638	1.96234	2.33008	2.58075	3.09840

θ	Condições	Intervalo de Confiança	Estatística de Teste	H_1	Região Crítica	p-value
μ	População com dist. normal e σ conhecido; ou $n > 30$ (se σ desconhecido usar s)	$\left]\overline{x} - z_{\alpha/2}\frac{\sigma}{\sqrt{n}},\ \overline{x} + z_{\alpha/2}\frac{\sigma}{\sqrt{n}}\right[$	$Z = \frac{\overline{X}-\mu_0}{\sigma/\sqrt{n}}$ $\mathcal{N}(0,1)$	$\mu \neq \mu_0$ $\mu < \mu_0$ $\mu > \mu_0$	$\lvert Z_{\text{calc}}\rvert > z_{\alpha/2}$ $Z_{\text{calc}} < -z_\alpha$ $Z_{\text{calc}} > z_\alpha$	$2P(Z > \lvert Z_{\text{calc}}\rvert)$ $P(Z < Z_{\text{calc}})$ $P(Z > Z_{\text{calc}})$
μ	População com dist. normal e σ desconhecido	$\left]\overline{x} - t_{\alpha/2}\frac{s}{\sqrt{n}},\ \overline{x} + t_{\alpha/2}\frac{s}{\sqrt{n}}\right[$	$T = \frac{\overline{X}-\mu_0}{S/\sqrt{n}}$ $t_{(n-1)}$	$\mu \neq \mu_0$ $\mu < \mu_0$ $\mu > \mu_0$	$\lvert T_{\text{calc}}\rvert > t_{\alpha/2}$ $T_{\text{calc}} < -t_\alpha$ $T_{\text{calc}} > t_\alpha$	$2P(T > \lvert T_{\text{calc}}\rvert)$ $P(T < T_{\text{calc}})$ $P(T > T_{\text{calc}})$
σ^2	População com dist. normal	$\left]\frac{(n-1)s^2}{\chi^2_{\alpha/2}},\ \frac{(n-1)s^2}{\chi^2_{1-\alpha/2}}\right[$	$\chi^2 = \frac{(n-1)S^2}{\sigma_0^2}$ $\chi^2_{(n-1)}$	$\sigma^2 \neq \sigma_0^2$ $\sigma^2 < \sigma_0^2$ $\sigma^2 > \sigma_0^2$	$\chi^2 < \chi^2_{1-\alpha/2}$ ou $\chi^2 > \chi^2_{\alpha/2}$ $\chi^2 < \chi^2_{1-\alpha}$ $\chi^2 > \chi^2_\alpha$	$2\min\left\{P(\chi^2 < \chi^2_{\text{calc}}),\ P(\chi^2 > \chi^2_{\text{calc}})\right\}$ $P(\chi^2 < \chi^2_{\text{calc}})$ $P(\chi^2 > \chi^2_{\text{calc}})$
p	n provas de Bernoulli independentes repetidas, n grande	$\left]\hat{p} - z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}},\ \hat{p} + z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}\right[$	$Z = \frac{\hat{P}-p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$ $\sim \mathcal{N}(0,1)$	$p \neq p_0$ $p < p_0$ $p > p_0$	$\lvert Z_{\text{calc}}\rvert > z_{\alpha/2}$ $Z_{\text{calc}} < -z_\alpha$ $Z_{\text{calc}} > z_\alpha$	$2P(Z > \lvert Z_{\text{calc}}\rvert)$ $P(Z < Z_{\text{calc}})$ $P(Z > Z_{\text{calc}})$
$\mu_1 - \mu_2$	Amostras independentes. Populações com dist. normal e σ_1 e σ_2 conhecidos; ou n_1 e n_2 grandes (se σ_1 e σ_2 desconhecidos usar s_1 e s_2)	$\left]\overline{x_1} - \overline{x_2} - z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}},\ \overline{x_1} - \overline{x_2} + z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}\right[$	$Z = \frac{\overline{X_1}-\overline{X_2}}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}}$ $\mathcal{N}(0,1)$	$\mu_1 \neq \mu_2$ $\mu_1 < \mu_2$ $\mu_1 > \mu_2$	$\lvert Z_{\text{calc}}\rvert > z_{\alpha/2}$ $Z_{\text{calc}} < -z_\alpha$ $Z_{\text{calc}} > z_\alpha$	$2P(Z > \lvert Z_{\text{calc}}\rvert)$ $P(Z < Z_{\text{calc}})$ $P(Z > Z_{\text{calc}})$
$\mu_1 - \mu_2$	Amostras independentes. Populações com dist. normal e σ_1 e σ_2 desconhecidos mas supostos iguais	$\left]\overline{x_1} - \overline{x_2} - t_{\alpha/2}\ s_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}},\ \overline{x_1} - \overline{x_2} + t_{\alpha/2}\ s_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}\right[$	$T = \frac{\overline{X_1}-\overline{X_2}}{S_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}$ $t_{(n_1+n_2-2)}$ $S_p = \sqrt{\frac{(n_1-1)S_1^2+(n_2-1)S_2^2}{(n_1+n_2-2)}}$	$\mu_1 \neq \mu_2$ $\mu_1 < \mu_2$ $\mu_1 > \mu_2$	$\lvert T_{\text{calc}}\rvert > t_{\alpha/2}$ $T_{\text{calc}} < -t_\alpha$ $T_{\text{calc}} > t_\alpha$	$2P(T > \lvert T_{\text{calc}}\rvert)$ $P(T < T_{\text{calc}})$ $P(T > T_{\text{calc}})$

θ	Condições	Intervalo de Confiança	Estatística de Teste	H_1	Região Crítica	p-value
$\mu_D = \mu_1 - \mu_2$	Amostras emparelhadas. População das diferenças com dist. normal e σ_D conhecido; ou $n > 30$ (se σ_D desconhecido usar s_D)	$\left]\bar{d} - z_{\alpha/2}\frac{\sigma_D}{\sqrt{n}},\ \bar{d} + z_{\alpha/2}\frac{\sigma_D}{\sqrt{n}}\right[$	$Z = \frac{\overline{D}}{\sigma_D/\sqrt{n}}$ $\mathcal{N}(0,1)$	$\mu_D \neq 0$	$\lvert Z_{\text{calc}}\rvert > z_{\alpha/2}$	$2P(Z > \lvert Z_{\text{calc}}\rvert)$
				$\mu_D < 0$	$Z_{\text{calc}} < -z_\alpha$	$P(Z < Z_{\text{calc}})$
				$\mu_D > 0$	$Z_{\text{calc}} > z_\alpha$	$P(Z > Z_{\text{calc}})$
$\mu_D = \mu_1 - \mu_2$	Amostras emparelhadas. População das diferenças com dist. normal e σ_D desconhecido	$\left]\bar{d} - t_{\alpha/2}\frac{s_D}{\sqrt{n}},\ \bar{d} + t_{\alpha/2}\frac{s_D}{\sqrt{n}}\right[$	$T = \frac{\overline{D}}{S_D/\sqrt{n}}$ $t_{(n-1)}$	$\mu_D \neq 0$	$\lvert T_{\text{calc}}\rvert > t_{\alpha/2}$	$2P(T > \lvert T_{\text{calc}}\rvert)$
				$\mu_D < 0$	$T_{\text{calc}} < -t_\alpha$	$P(T < T_{\text{calc}})$
				$\mu_D > 0$	$T_{\text{calc}} > t_\alpha$	$P(T > T_{\text{calc}})$
σ_1^2/σ_2^2	Amostras independentes. Populações com distribuição normal.	$\left]\frac{s_1^2}{s_2^2}\frac{1}{f_{\alpha/2}},\ \frac{s_1^2}{s_2^2}\frac{1}{f_{1-\alpha/2}}\right[$	$F = \frac{S_1^2}{S_2^2}$ $F_{(n_1-1,\, n_2-1)}$	$\sigma_1^2 \neq \sigma_2^2$	$F < f_{1-\alpha/2}$ ou $F > f_{\alpha/2}$	$2\min\{P(F < F_{\text{calc}}),\ P(F > F_{\text{calc}})\}$
				$\sigma_1^2 < \sigma_2^2$	$F < f_{1-\alpha}$	$P(F < F_{\text{calc}})$
				$\sigma_1^2 > \sigma_2^2$	$F > f_\alpha$	$P(F > F_{\text{calc}})$
$p_1 - p_2$	Provas independentes repetidas, n_1 e n_2 grandes	$\left]\hat{p}_1 - \hat{p}_2 - z_{\alpha/2}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_2\hat{q}_2}{n_2}},\ \hat{p}_1 - \hat{p}_2 + z_{\alpha/2}\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_2\hat{q}_2}{n_2}}\right[$	$Z = \frac{\widehat{P_1} - \widehat{P_2}}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$ $\sim \mathcal{N}(0,1)$ $\hat{p} = \frac{n_1p_1 + n_2p_2}{n_1 + n_2}$	$p_1 \neq p_2$	$\lvert Z_{\text{calc}}\rvert > z_{\alpha/2}$	$2P(Z > \lvert Z_{\text{calc}}\rvert)$
				$p_1 < p_2$	$Z_{\text{calc}} < -z_\alpha$	$P(Z < Z_{\text{calc}})$
				$p_1 > p_2$	$Z_{\text{calc}} > z_\alpha$	$P(Z > Z_{\text{calc}})$