Verteilungstabellen

1 Standardnormalverteilung

Tabelliert sind die Werte der Verteilungsfunktion $\Phi(z) = P(Z \leq z)$ für $z \geq 0$.
Ablesebeispiel: $\Phi(1.75) = 0.9599$
Funktionswerte für negative Argumente: $\Phi(-z) = 1 - \Phi(z)$
Die z-Quantile ergeben sich genau umgekehrt.
Beispielsweise ist $z(0.9599) = 1.75$ und $z(0.9750) = 1.96$.

	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
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998

2 Students *t*-Verteilung

Tabelliert sind die Quantile für n Freiheitsgrade.
Für das Quantil $t_{1-\alpha}(n)$ gilt $F(t_{1-\alpha}(n)) = 1 - \alpha$.
Links vom Quantil $t_{1-\alpha}(n)$ liegt die Wahrscheinlichkeitsmasse $1 - \alpha$.
Ablesebeispiel: $t_{0.99}(20) = 2.528$
Die Quantile für $0 < 1 - \alpha < 0.5$ erhält man aus $t_\alpha(n) = -t_{1-\alpha}(n)$

Approximation für $n > 30$:

$$t_\alpha(n) \approx z_\alpha \quad (z_\alpha \text{ ist das } (\alpha)\text{-Quantil der Standardnormalverteilung})$$

n	0.6	0.8	0.9	0.95	0.975	0.99	0.995	0.999	0.9995
1	0.3249	1.3764	3.0777	6.3138	12.706	31.821	63.657	318.31	636.62
2	0.2887	1.0607	1.8856	2.9200	4.3027	6.9646	9.9248	22.327	31.599
3	0.2767	0.9785	1.6377	2.3534	3.1824	4.5407	5.8409	10.215	12.924
4	0.2707	0.9410	1.5332	2.1318	2.7764	3.7469	4.6041	7.1732	8.6103
5	0.2672	0.9195	1.4759	2.0150	2.5706	3.3649	4.0321	5.8934	6.8688
6	0.2648	0.9057	1.4398	1.9432	2.4469	3.1427	3.7074	5.2076	5.9588
7	0.2632	0.8960	1.4149	1.8946	2.3646	2.9980	3.4995	4.7853	5.4079
8	0.2619	0.8889	1.3968	1.8595	2.3060	2.8965	3.3554	4.5008	5.0413
9	0.2610	0.8834	1.3830	1.8331	2.2622	2.8214	3.2498	4.2968	4.7809
10	0.2602	0.8791	1.3722	1.8125	2.2281	2.7638	3.1693	4.1437	4.5869
11	0.2596	0.8755	1.3634	1.7959	2.2010	2.7181	3.1058	4.0247	4.4370
12	0.2590	0.8726	1.3562	1.7823	2.1788	2.6810	3.0545	3.9296	4.3178
13	0.2586	0.8702	1.3502	1.7709	2.1604	2.6503	3.0123	3.8520	4.2208
14	0.2582	0.8681	1.3450	1.7613	2.1448	2.6245	2.9768	3.7874	4.1405
15	0.2579	0.8662	1.3406	1.7531	2.1314	2.6025	2.9467	3.7328	4.0728
16	0.2576	0.8647	1.3368	1.7459	2.1199	2.5835	2.9208	3.6862	4.0150
17	0.2573	0.8633	1.3334	1.7396	2.1098	2.5669	2.8982	3.6458	3.9651
18	0.2571	0.8620	1.3304	1.7341	2.1009	2.5524	2.8784	3.6105	3.9216
19	0.2569	0.8610	1.3277	1.7291	2.0930	2.5395	2.8609	3.5794	3.8834
20	0.2567	0.8600	1.3253	1.7247	2.0860	2.5280	2.8453	3.5518	3.8495
21	0.2566	0.8591	1.3232	1.7207	2.0796	2.5176	2.8314	3.5272	3.8193
22	0.2564	0.8583	1.3212	1.7171	2.0739	2.5083	2.8188	3.5050	3.7921
23	0.2563	0.8575	1.3195	1.7139	2.0687	2.4999	2.8073	3.4850	3.7676
24	0.2562	0.8569	1.3178	1.7109	2.0639	2.4922	2.7969	3.4668	3.7454
25	0.2561	0.8562	1.3163	1.7081	2.0595	2.4851	2.7874	3.4502	3.7251
26	0.2560	0.8557	1.3150	1.7056	2.0555	2.4786	2.7787	3.4350	3.7066
27	0.2559	0.8551	1.3137	1.7033	2.0518	2.4727	2.7707	3.4210	3.6896
28	0.2558	0.8546	1.3125	1.7011	2.0484	2.4671	2.7633	3.4082	3.6739
29	0.2557	0.8542	1.3114	1.6991	2.0452	2.4620	2.7564	3.3962	3.6594
30	0.2556	0.8538	1.3104	1.6973	2.0423	2.4573	2.7500	3.3852	3.6460
∞	0.2533	0.8416	1.2816	1.6449	1.9600	2.3263	2.5758	3.0903	3.2906

3 χ^2-Verteilung

Tabelliert sind die Quantile für n Freiheitsgrade.
Für das Quantil $\chi^2_{1-\alpha}(n)$ gilt $F(\chi^2_{1-\alpha}(n)) = 1 - \alpha$.
Links vom Quantil $\chi^2_{1-\alpha}(n)$ liegt die Wahrscheinlichkeitsmasse $1 - \alpha$.
Ablesebeispiel: $\chi^2_{0.95}(10) = 18.307$

Approximation für $n > 30$:

$$\chi^2_\alpha(n) \approx \frac{1}{2}(z_\alpha + \sqrt{2n-1})^2 \quad (z_\alpha \text{ ist das } \alpha\text{-Quantil der Standardnormalverteilung})$$

n	0.01	0.025	0.05	0.1	0.5	0.9	0.95	0.975	0.99
1	0.0002	0.0010	0.0039	0.0158	0.4549	2.7055	3.8415	5.0239	6.6349
2	0.0201	0.0506	0.1026	0.2107	1.3863	4.6052	5.9915	7.3778	9.2103
3	0.1148	0.2158	0.3518	0.5844	2.3660	6.2514	7.8147	9.3484	11.345
4	0.2971	0.4844	0.7107	1.0636	3.3567	7.7794	9.4877	11.143	13.277
5	0.5543	0.8312	1.1455	1.6103	4.3515	9.2364	11.070	12.833	15.086
6	0.8721	1.2373	1.6354	2.2041	5.3481	10.645	12.592	14.449	16.812
7	1.2390	1.6899	2.1674	2.8331	6.3458	12.017	14.067	16.013	18.475
8	1.6465	2.1797	2.7326	3.4895	7.3441	13.362	15.507	17.535	20.090
9	2.0879	2.7004	3.3251	4.1682	8.3428	14.684	16.919	19.023	21.666
10	2.5582	3.2470	3.9403	4.8652	9.3418	15.987	18.307	20.483	23.209
11	3.0535	3.8157	4.5748	5.5778	10.341	17.275	19.675	21.920	24.725
12	3.5706	4.4038	5.2260	6.3038	11.340	18.549	21.026	23.337	26.217
13	4.1069	5.0088	5.8919	7.0415	12.340	19.812	22.362	24.736	27.688
14	4.6604	5.6287	6.5706	7.7895	13.339	21.064	23.685	26.119	29.141
15	5.2293	6.2621	7.2609	8.5468	14.339	22.307	24.996	27.488	30.578
16	5.8122	6.9077	7.9616	9.3122	15.338	23.542	26.296	28.845	32.000
17	6.4078	7.5642	8.6718	10.085	16.338	24.769	27.587	30.191	33.409
18	7.0149	8.2307	9.3905	10.865	17.338	25.989	28.869	31.526	34.805
19	7.6327	8.9065	10.117	11.651	18.338	27.204	30.144	32.852	36.191
20	8.2604	9.5908	10.851	12.443	19.337	28.412	31.410	34.170	37.566
21	8.8972	10.283	11.591	13.240	20.337	29.615	32.671	35.479	38.932
22	9.5425	10.982	12.338	14.041	21.337	30.813	33.924	36.781	40.289
23	10.196	11.689	13.091	14.848	22.337	32.007	35.172	38.076	41.638
24	10.856	12.401	13.848	15.659	23.337	33.196	36.415	39.364	42.980
25	11.524	13.120	14.611	16.473	24.337	34.382	37.652	40.646	44.314
26	12.198	13.844	15.379	17.292	25.336	35.563	38.885	41.923	45.642
27	12.879	14.573	16.151	18.114	26.336	36.741	40.113	43.195	46.963
28	13.565	15.308	16.928	18.939	27.336	37.916	41.337	44.461	48.278
29	14.256	16.047	17.708	19.768	28.336	39.087	42.557	45.722	49.588
30	14.953	16.791	18.493	20.599	29.336	40.256	43.773	46.979	50.892

4 Wilcoxon-Vorzeichen-Rang-Test

Kritische Werte $w^+_{n;\gamma}$ des Vorzeichen-Rang-Tests von Wilcoxon

n	$w^+_{n;0.01}$	$w^+_{n;0.025}$	$w^+_{n;0.05}$	$w^+_{n;0.10}$	$w^+_{n;0.90}$	$w^+_{n;0.95}$	$w^+_{n;0.975}$	$w^+_{n;0.99}$
4	0	0	0	1	8	9	10	10
5	0	0	1	3	11	13	14	14
6	0	1	3	4	16	17	19	20
7	1	3	4	6	21	23	24	26
8	2	4	6	9	26	29	31	33
9	4	6	9	11	33	35	38	40
10	6	9	11	15	39	43	45	57
11	8	11	14	18	47	51	54	57
12	10	14	18	22	55	59	62	66
13	13	18	22	27	63	68	72	77
14	16	22	26	32	72	78	82	88
15	20	26	31	37	82	88	93	99
16	24	30	36	43	92	99	105	111
17	28	35	42	49	103	110	117	124
18	33	41	48	56	114	122	129	137
19	38	47	54	63	126	135	142	151
20	44	53	61	70	139	148	156	165

5 Binomialverteilung (p=0.5!)

$p = 0.5$	n=1	n=2	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14	n=15
$x \leq 0$	0.5000	0.2500	0.1250	0.0625	0.0313	0.0156	0.0078	0.0039	0.0020	0.0010	0.0005	0.0002	0.0001	0.0001	0.0000
1	1.0000	0.7500	0.5000	0.3125	0.1875	0.1094	0.0625	0.0352	0.0195	0.0107	0.0059	0.0032	0.0017	0.0009	0.0005
2	.	1.0000	0.8750	0.6875	0.5000	0.3438	0.2266	0.1445	0.0898	0.0547	0.0327	0.0193	0.0112	0.0065	0.0037
3	.	.	1.0000	0.9375	0.8125	0.6562	0.5000	0.3633	0.2539	0.1719	0.1133	0.0730	0.0461	0.0287	0.0176
4	.	.	.	1.0000	0.9688	0.8906	0.7734	0.6367	0.5000	0.3770	0.2744	0.1938	0.1334	0.0898	0.0592
5	.	.	.	.	1.0000	0.9844	0.9375	0.8555	0.7461	0.6230	0.5000	0.3872	0.2905	0.2120	0.1509
6	.	.	.	.	.	1.0000	0.9922	0.9648	0.9102	0.8281	0.7256	0.6128	0.5000	0.3953	0.3036
7	.	.	.	.	.	.	1.0000	0.9961	0.9805	0.9453	0.8867	0.8062	0.7095	0.6047	0.5000
8	.	.	.	.	.	.	.	1.0000	0.9980	0.9893	0.9673	0.9270	0.8666	0.7880	0.6964
9	.	.	.	.	.	.	.	.	1.0000	0.9990	0.9941	0.9807	0.9539	0.9102	0.8491
10	.	.	.	.	.	.	.	.	.	1.0000	0.9995	0.9968	0.9888	0.9713	0.9408
11	.	.	.	.	.	.	.	.	.	.	1.0000	0.9998	0.9983	0.9935	0.9824
12	.	.	.	.	.	.	.	.	.	.	.	1.0000	0.9999	0.9991	0.9963
13	.	.	.	.	.	.	.	.	.	.	.	.	1.0000	0.9999	0.9995
14	.	.	.	.	.	.	.	.	.	.	.	.	.	1.0000	1.0000
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.0000

$p = 0.5$	n=16	n=17	n=18	n=19	n=20	n=21	n=22	n=23	n=24	n=25	n=26	n=27	n=28	n=29	n=30
$x \leq 0$	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0003	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0021	0.0012	0.0007	0.0004	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0106	0.0064	0.0038	0.0022	0.0013	0.0007	0.0004	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0384	0.0245	0.0154	0.0096	0.0059	0.0036	0.0022	0.0013	0.0008	0.0005	0.0003	0.0002	0.0001	0.0001	0.0000
5	0.1051	0.0717	0.0481	0.0318	0.0207	0.0133	0.0085	0.0053	0.0033	0.0020	0.0012	0.0008	0.0005	0.0003	0.0002
6	0.2272	0.1662	0.1189	0.0835	0.0577	0.0392	0.0262	0.0173	0.0113	0.0073	0.0047	0.0030	0.0019	0.0012	0.0007
7	0.4018	0.3145	0.2403	0.1796	0.1316	0.0946	0.0669	0.0466	0.0320	0.0216	0.0145	0.0096	0.0063	0.0041	0.0026
8	0.5982	0.5000	0.4073	0.3238	0.2517	0.1917	0.1431	0.1050	0.0758	0.0539	0.0378	0.0261	0.0178	0.0121	0.0081
9	0.7728	0.6855	0.5927	0.5000	0.4119	0.3318	0.2617	0.2024	0.1537	0.1148	0.0843	0.0610	0.0436	0.0307	0.0214
10	0.8949	0.8338	0.7597	0.6762	0.5881	0.5000	0.4159	0.3388	0.2706	0.2122	0.1635	0.1239	0.0925	0.0680	0.0494
11	0.9616	0.9283	0.8811	0.8204	0.7483	0.6682	0.5841	0.5000	0.4194	0.3450	0.2786	0.2210	0.1725	0.1325	0.1002
12	0.9894	0.9755	0.9519	0.9165	0.8684	0.8083	0.7383	0.6612	0.5806	0.5000	0.4225	0.3506	0.2858	0.2291	0.1808
13	0.9979	0.9936	0.9846	0.9682	0.9423	0.9054	0.8569	0.7976	0.7294	0.6550	0.5775	0.5000	0.4253	0.3555	0.2923
14	0.9997	0.9988	0.9962	0.9904	0.9793	0.9608	0.9331	0.8950	0.8463	0.7878	0.7214	0.6494	0.5747	0.5000	0.4278
15	1.0000	0.9999	0.9993	0.9978	0.9941	0.9867	0.9738	0.9534	0.9242	0.8852	0.8365	0.7790	0.7142	0.6445	0.5722
16	1.0000	1.0000	0.9999	0.9996	0.9987	0.9964	0.9915	0.9827	0.9680	0.9461	0.9157	0.8761	0.8275	0.7709	0.7077
17	.	1.0000	1.0000	1.0000	0.9998	0.9993	0.9978	0.9947	0.9887	0.9784	0.9622	0.9390	0.9075	0.8675	0.8192
18	.	.	1.0000	1.0000	1.0000	0.9999	0.9996	0.9987	0.9967	0.9927	0.9855	0.9739	0.9564	0.9320	0.8998
19	.	.	.	1.0000	1.0000	1.0000	0.9999	0.9998	0.9992	0.9980	0.9953	0.9904	0.9822	0.9693	0.9506
20	.	.	.	.	1.0000	1.0000	1.0000	1.0000	0.9999	0.9995	0.9988	0.9970	0.9937	0.9879	0.9786
21	.	.	.	.	.	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9992	0.9981	0.9959	0.9919
22	.	.	.	.	.	.	1.0000	1.0000	1.0000	1.0000	1.0000	0.9998	0.9995	0.9988	0.9974
23	.	.	.	.	.	.	.	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9993
24	.	.	.	.	.	.	.	.	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9998
25	.	.	.	.	.	.	.	.	.	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
26	.	.	.	.	.	.	.	.	.	.	1.0000	1.0000	1.0000	1.0000	1.0000
27	.	.	.	.	.	.	.	.	.	.	.	1.0000	1.0000	1.0000	1.0000
28	.	.	.	.	.	.	.	.	.	.	.	.	1.0000	1.0000	1.0000
29	.	.	.	.	.	.	.	.	.	.	.	.	.	1.0000	1.0000
30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.0000

6 Wilcoxon-Rangsummen-Test

Tabelliert sind die kritische Werte $w_{\alpha=0.05}$.
Ablesebeispiel: Für $n = 3$ und $m = 7$ ist $w_{0.05} = 9$
Es ist $w_{1-\alpha}(n, m) = n(n + m + 1) - w_\alpha(n, m)$

n/m	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	3	3	3	4	4	4	5	5	5	5	6	6	7	7	7	7	8	8	8
3	6	7	7	8	9	9	10	11	11	12	12	13	14	14	15	16	16	17	18
4	10	11	12	13	14	15	16	17	18	19	20	21	22	23	25	26	27	28	29
5	16	17	18	20	21	22	24	25	27	28	29	31	32	34	35	36	38	39	41
6	22	24	25	27	29	30	32	34	36	38	39	41	43	45	47	48	50	52	54
7	29	31	33	35	37	40	42	44	46	48	50	53	55	57	59	62	64	66	68
8	38	40	42	45	47	50	52	55	57	60	63	65	68	70	73	76	78	81	84
9	47	50	52	55	58	61	64	67	70	73	76	79	82	85	88	91	94	97	100
10	57	60	63	67	70	73	76	80	83	87	90	93	97	100	104	107	111	114	118
11	68	72	75	79	83	86	90	94	98	101	105	109	113	117	121	124	128	132	136
12	81	84	88	92	96	100	105	109	113	117	121	126	130	134	139	143	147	151	156
13	94	98	102	107	111	116	120	125	129	134	139	143	148	153	157	162	167	172	176
14	109	113	117	122	127	132	137	142	147	152	157	162	167	172	177	183	188	193	198
15	124	128	133	139	144	149	154	160	165	171	176	182	187	193	198	204	209	215	221
16	140	145	151	156	162	167	173	179	185	191	197	202	208	214	220	226	232	238	244
17	157	163	169	174	180	187	193	199	205	211	218	224	231	237	243	250	256	263	269
18	176	181	188	194	200	207	213	220	227	233	240	247	254	260	267	274	281	288	295
19	195	201	208	214	221	228	235	242	249	256	263	271	278	285	292	300	307	314	321
20	215	222	229	236	243	250	258	265	273	280	288	295	303	311	318	326	334	341	349