國立成功大學

115學年度碩士班招生考試試題

編　號：157

系　所：統計與資料科學學系

科　目：統計學

日　期：0204

節　次：第 3 節

注　意：1.不可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

INSTRUCTIONS

- Each of questions 1 to 25 and 28 to 34 is worth 3 marks, each of 26 and 27 is worth 2 marks. Circle the best answer out of five for each question.

Please refer to the following to help you answer questions 1 to 9.

An ecologist wants to study the dietary of young adult blue crabs while feeding them on clams. She drops 150 live clams in each of the large aquarium of the same size at the same hour on the same day, and is wondering if the number of blue crabs living in an aquarium will give explanation to the number of live clams remaining (mutually independent across all aquarium) two days later by using a least-squares simple linear regression model. The number of crabs living in an aquarium and the number of remaining live clams at the time of observation are as shown in the following table. It is calculated that the total number of crabs in all aquariums is 34, the

Aquarium	1	2	3	4	5	6	7	8
Number of crabs	4	2	8	3	2	6	4	5
Number of clams	81	90	7	61	80	43	64	59

total number of live clams remaining is 485, the number of crabs squared has a total of 174, the number of remaining live clams squared has a total of 34257, the product of the two variables has a total of 1712.

1. The fraction of the variation in remaining live clams that can be accounted for by linearly regressing it on number of blue crabs is

   (A) 0.812 (B) −0.923 (C) 0.852 (D) 0.986 (E) 0.685

2. The slope of the estimated regression equation is

   (A) −11.84 (B) 17.4 (C) −2.77 (D) 0.835 (E) −0.09

3. The intercept of the estimated regression equation is

   (A) 9.78 (B) 110.94 (C) 129.47 (D) 8.79 (E) −0.09

4. What is the residual in prediction of number of remaining live clams for the aquarium with three blue crabs living in it?

   (A) −14.42 (B) −11.536 (C) 15.88 (D) 18.54 (E) 14.03

5. Which of the following is the best estimate for the mean of all residuals?

   (A) 0 (B) 1.96 (C) −3.28 (D) 0.95 (E) 1

6. It is calculated that the sum of squares of all residuals is 719.1102, the statistic for testing whether the true value of the slope of the model is zero or not, while assuming that the random error of the model is normally distributed, would have an observed value of

   (A) 4.61 (B) −1.43 (C) 3.13 (D) 3.23 (E) −5.874

7. Which of the following is the best estimate for the standard deviation of all residuals?

   (A) 1 (B) 1.968 (C) 2.131 (D) 0.954 (E) 10.14

8. To test whether the mean of the distribution of number of remaining live clams in an aquarium is 50 or not, while assuming that the distribution is normal, the observed value of the test statistic is

   (A) 0.76 (B) −2.81 (C) 1.14 (D) 0.62 (E) incalculable

9. The p-value to the appropriate test for the last question is

   (A) between 0.1 and 0.2

   (B) greater than 0.5

   (C) smaller than 0.05

   (D) between 0.2 and 0.3

   (E) incalculable

Please refer to the following to help you answer questions 10 to 11.

A random sample of 100 printed circuit boards is taken and the number of defects on each board is recorded, results of which is shown in the following table. Knowing that $e^{-0.8} = 0.44933$ and $e^{0.8} = 2.225541$, and if number of defects found on each board is assumed to follow a Poisson distribution with mean 0.8,

Number of defects	0	1	2	3 or more
Number of boards in the sample with above number of defects	46	21	12	8

10. the probability of observing two defects on a randomly selected board approximately is

(A) 0.4493 (B) 0.3595 (C) 0.0474 (D) 0.1438 (E) 0.4526

11. To test whether the assumption on the Poisson distribution for number of defects observed on a board seem appropriate, the observed value of the test statistic is

(A) 13.59 (B) −2.88 (C) 5.06 (D) 1.37 (E) incalculable

12. Angela is taking an accounting course, and his instructor states in the course outline that the final grade received by any student for the course is contributed by

Term test 1	10%
Term test 2	15%
Term test 3	15%
Term test 4	20%
Final exam	40%

All exams are out of 100 marks. Angela received scores of 70 on term test 1, 60 on term test 2, 80 on term test 3, and 75 on term test 4. To receive a final grade of B+ in the course, a student requires a final grade of 75 or higher. What is the minimum score Angela must get on the final exam in order to receive a final grade of B+?

(A) 90.5 (B) 70 (C) 75.5 (D) 75 (E) 80

Please refer to the following to help you answer questions 13 to 16.

The instructor of Angela's Statistics class learns from the past that 10% of all students enrolled in the same course have earned a final grade of A or above.

13. What is the probability that, of ten randomly chosen students from Angela's class, exactly one will earn a final grade of A or above?

(A) 0.1 (B) 0.9936 (C) 0.8863 (D) 0.0328 (E) 0.3874

14. What is the probability that, of five randomly chosen students from Angela's class, no one will earn a final grade of A or above?

(A) 0.5905 (B) almost 0 (C) 0.0003 (D) 0.1074 (E) 0.2843

15. There are ninety students in Angela's class, how many do you expect will earn a final grade of A or above?

(A) 14 (B) 10 (C) 9 (D) 15 (E) 21

16. Continue from question 15, the probability that more than forty-four students in Angela's class will earn a final grade of A or above is approximately

(A) 0.05 (B) almost 0 (C) 0.9 (D) 0.1 (E) 0.5

Please refer to the following to help you answer questions 17 to 22.

The annual rainfall in Tainan city follows a normal distribution with the standard deviation known to be 38 mm, and assuming that rainfall for any one-year period is independent of one another.

17. In 20% of years in past history, the city gets over 2200 mm of rain. What is the mean annual rainfall in Tainan city (in mm)?

(A) 2232.819 (B) 34.702 (C) 32.654 (D) 2168.018 (E) 2238.154

18. Continue from the last question, of June each year if it is noticed that annual rainfall (for the past 12 months) is to reach two standard deviation below the mean or less, a water shortage warning is to be issued by the city government. What is the probability that a warning is to be issued in June in a typical year?

(A) 0.0228 (B) 0.9772 (C) 0.0188 (D) 0.0255 (E) 0.925

19. Continue from question 17, the third quartile of the distribution of the amount of annual rainfall in Tainan city is

(A) 2193.65 (B) 3141.96 (C) 2877.35 (D) 3579.48 (E) 1602.85

20. Over a ten-year period, the probability of observing an average annual rainfall for the ten years having the same value of the mean annual rainfall found in question 17 is

(A) 0.5675 (B) 0.5388 (C) 0 (D) 0.5 (E) 0.4899

21. Over a ten-year period, the probability of observing an average annual rainfall of 2130 mm or less is

(A) 0.0037 (B) 0.0217 (C) 0.0212 (D) 0.0008 (E) 0.0073

22. Continue from question 17, the minimum value (in mm) we can use to characterize the top 20% in annual rainfall is

(A) 3362.922 (B) 5.753 (C) 58.846 (D) 2200.000 (E) 5078.144

Please refer to the following to help you answer questions 23 to 25.

At a nearby shopping mall a statistician analyzed that, the amount spent by customers in a grocery store follows some distribution with mean μ (in dollar) and variance 1324 (in dollar^2) on New Year's Day, and independent of grocery purchases, the amount spent by customers in a gift shop follows some distribution with mean 204 (in dollar) and variance 1089 (in dollar^2).

23. It is estimated that the mean of total spending on grocery and gifts by a customer at the mall on New Year's Day is 620. Which of the following is a reasonable estimate for the mean amount of spending by customers in a grocery store?

(A) 310 (B) 416 (C) 765 (D) 408 (E) It can not be estimated.

24. Continue from the last question, while assuming that spending in a grocery store and spending in a gift shop are normally distributed, what is the probability that a randomly surveyed customer will spend more than 720 on New Year's Day?

(A) 0.021 (B) 0.004 (C) 0.653 (D) 0.131 (E) It can not be calculated.

25. What minimum sample size would be required in order to estimate μ to within 15 with 95% confidence while assuming that spending in a grocery store is normally distributed?

(A) 23 (B) 128 (C) 16 (D) 45 (E) 76

26. The school principal of an elementary school wants to determine whether student performance in an aptitude test in math course differs depending on their grade (from Kindergarten to Grade 6) and the time of day the math class is taught. Grade-4, -5 and -6 students are asked to take the same aptitude test, students in each grade are separated into either the morning math class or the afternoon math class according to students preference of enrolment at the beginning of school year. At the end of the year, the principal will analyze and compare the average grades of the students in the six classes. This example describes

(A) a census.

(B) an observational study.

(C) an experiment of completely randomized design with four treatments.

(D) a sample survey intended for three target populations.

(E) an experiment of matched pairs design with two treatments.

27. The NCKU Student Union has recently left a message on Facebook inquiring about the opinion of removing the penalty of put students on academic suspension for failing more than 1/2 of total credit hours of course enrolment in a semester. A QR code is made available everywhere on the university campus for all those who wish to submit their opinions on this topic through mobile phones. Everyone who, collectively, submits his or her response through the survey is a part of a

(A) systematic random sample.

(B) complete random sample.

(C) probability sample.

(D) convenience sample.

(E) voluntary response sample.

Please refer to the following line of random digits to help you answer questions 28 to 30.

31214 12231 51371 36240 58253 05092 50287 23253 60399 79270 24863 97576 01139

We are given the instructions by the University information technology staff that students associated with the institution are to reset the password for their email accounts.

28. Suppose only the lowercase English alphabet letters can be used for creating a password 8 characters long while allowing for repeated characters in the chosen password, which of the following is a possible randomly generated password by using the random digits?

(A) newyearn (B) kauboqu (C) foodiemo (D) bdluuylc (E) akvrjjmt

29. Suppose only the lowercase English alphabet letters can be used for creating a password 8 characters long while repeating characters in the chosen password is not allowed, which of the following is a possible randomly generated password by the random digits?

(A) bookworm (B) wpqziyav (C) lnvpfmx (D) kaubqtej (E) jetqkaub

30. Which of the following is NOT true about the line of random digits in the above?

I. The first digit is equally likely to be any digit other than 9.

II. The first two digits are equally likely to be 33 if not 18.

III. The first two digits are less likely to be 33 if not 18.

IV. The probability of the first two letters to be included in the password being 'a' and 'b' is 1/100.

V. The probability of the first two letters to be included in the password being 'a' and 'b' in question 16 is 0.

(A) III, IV and V (B) IV only (C) II, III and IV (D) II and IV (E) III only

Please refer to the following to help you answer questions 31 to 32.

We take a sample of 25 trees in a large forest and measure the height of each. Denote the mean height of trees in the forest by μ, the sample mean is calculated to be 29.3 feet and the sample standard deviation is calculated to be 5.3 feet.

31. Which of the following is considered a 95% confidence interval for μ?

(A) (25.31, 33.57)

(B) (25.33, 33.55)

(C) (27.11, 31.49)

(D) (27.22, 31.38)

(E) (27.25, 31.35)

32. Which of the following is NOT required for the answer to question 31 to be valid?

I. The use of the central limit theorem.

II. The sample to be randomly selected from the forest.

III. Tree height to be normally distributed.

IV. The variance of the distribution of tree height.

V. The 0.95th quantile of the Student's t-distribution associated with 24 degrees of freedom.

(A) I and III (B) I, IV and V (C) I only (D) V only (E) II, III and IV

Please refer to the following to help you answer questions 33 to 34.

A market research is interested in finding out the true proportion p of NCKU students who live off-campus. Five hundred randomly selected NCKU students in this city are surveyed to determine whether they live on- or off-campus. Of the 500 people surveyed, 362 responded that they live off-campus.

33. A 90% confidence interval for p can be constructed as

(A) (0.5033, 0.8244)

(B) (0.6911, 0.7569)

(C) (0.6879, 0.7085)

(D) (0.5133, 0.8355)

(E) (0.6722, 0.7788)

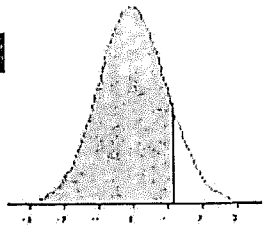
34. If we desire that the interval estimate for p in the last question to be no wider than 0.1, the minimum required sample size would be

(A) 124 (B) 608 (C) 534 (D) 271 (E) 1067

Table of the standard normal cumulative distribution function $P(Z < z)$ where $Z \sim N(0,1)$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
-0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
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

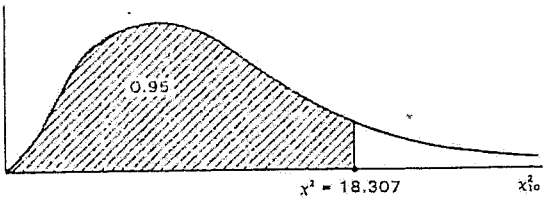
Student's t-distribution table



	p										
df	0.75	0.80	0.85	0.90	0.95	0.975	0.980	0.990	0.995	0.9975	0.9990
1	1.0000	1.3764	1.9626	3.0777	6.3137	12.706	15.895	31.821	63.656	127.32	318.29
2	0.8165	1.0607	1.3862	1.8856	2.9200	4.3027	4.8487	6.9645	9.9250	14.089	22.329
3	0.7649	0.9785	1.2498	1.6377	2.3534	3.1824	3.4819	4.5407	5.8408	7.4532	10.214
4	0.7407	0.9410	1.1896	1.5332	2.1318	2.7765	2.9985	3.7469	4.6041	5.5975	7.1729
5	0.7267	0.9195	1.1558	1.4759	2.0150	2.5706	2.7565	3.3649	4.0321	4.7733	5.8935
6	0.7176	0.9057	1.1342	1.4398	1.9432	2.4469	2.6122	3.1427	3.7074	4.3168	5.2075
7	0.7111	0.8960	1.1192	1.4149	1.8946	2.3646	2.5168	2.9979	3.4995	4.0294	4.7853
8	0.7064	0.8889	1.1081	1.3968	1.8595	2.3060	2.4490	2.8965	3.3554	3.8325	4.5008
9	0.7027	0.8834	1.0997	1.3830	1.8331	2.2622	2.3984	2.8214	3.2498	3.6896	4.2969
10	0.6998	0.8791	1.0931	1.3722	1.8125	2.2281	2.3593	2.7638	3.1693	3.5814	4.1437
11	0.6974	0.8755	1.0877	1.3634	1.7959	2.2010	2.3281	2.7181	3.1058	3.4966	4.0248
12	0.6955	0.8726	1.0832	1.3562	1.7823	2.1788	2.3027	2.6810	3.0545	3.4284	3.9296
13	0.6938	0.8702	1.0795	1.3502	1.7709	2.1604	2.2816	2.6503	3.0123	3.3725	3.8520
14	0.6924	0.8681	1.0763	1.3450	1.7613	2.1448	2.2638	2.6245	2.9768	3.3257	3.7874
15	0.6912	0.8662	1.0735	1.3406	1.7531	2.1315	2.2485	2.6025	2.9467	3.2860	3.7329
16	0.6901	0.8647	1.0711	1.3368	1.7459	2.1199	2.2354	2.5835	2.9208	3.2520	3.6861
17	0.6892	0.8633	1.0690	1.3334	1.7396	2.1098	2.2238	2.5669	2.8982	3.2224	3.6458
18	0.6884	0.8620	1.0672	1.3304	1.7341	2.1009	2.2137	2.5524	2.8784	3.1966	3.6105
19	0.6876	0.8610	1.0655	1.3277	1.7291	2.0930	2.2047	2.5395	2.8609	3.1737	3.5793
20	0.6870	0.8600	1.0640	1.3253	1.7247	2.0860	2.1967	2.5280	2.8453	3.1534	3.5518
21	0.6864	0.8591	1.0627	1.3232	1.7207	2.0796	2.1894	2.5176	2.8314	3.1352	3.5271
22	0.6858	0.8583	1.0614	1.3212	1.7171	2.0739	2.1829	2.5083	2.8188	3.1188	3.5050
23	0.6853	0.8575	1.0603	1.3195	1.7139	2.0687	2.1770	2.4999	2.8073	3.1040	3.4850
24	0.6848	0.8569	1.0593	1.3178	1.7109	2.0639	2.1715	2.4922	2.7970	3.0905	3.4668
25	0.6844	0.8562	1.0584	1.3163	1.7081	2.0595	2.1666	2.4851	2.7874	3.0782	3.4502
26	0.6840	0.8557	1.0575	1.3150	1.7056	2.0555	2.1620	2.4786	2.7787	3.0669	3.4350
27	0.6837	0.8551	1.0567	1.3137	1.7033	2.0518	2.1578	2.4727	2.7707	3.0565	3.4210
28	0.6834	0.8546	1.0560	1.3125	1.7011	2.0484	2.1539	2.4671	2.7633	3.0470	3.4082
29	0.6830	0.8542	1.0553	1.3114	1.6991	2.0452	2.1503	2.4620	2.7564	3.0380	3.3963
30	0.6828	0.8538	1.0547	1.3104	1.6973	2.0423	2.1470	2.4573	2.7500	3.0298	3.3852
31	0.6825	0.8534	1.0541	1.3095	1.6955	2.0395	2.1438	2.4528	2.7440	3.0221	3.3749
32	0.6822	0.8530	1.0535	1.3086	1.6939	2.0369	2.1409	2.4487	2.7385	3.0149	3.3653
33	0.6820	0.8526	1.0530	1.3077	1.6924	2.0345	2.1382	2.4448	2.7333	3.0082	3.3563
34	0.6818	0.8523	1.0525	1.3070	1.6909	2.0322	2.1356	2.4411	2.7284	3.0020	3.3480
35	0.6816	0.8520	1.0520	1.3062	1.6896	2.0301	2.1332	2.4377	2.7238	2.9961	3.3400
36	0.6814	0.8517	1.0516	1.3055	1.6883	2.0281	2.1309	2.4345	2.7195	2.9905	3.3326
37	0.6812	0.8514	1.0512	1.3049	1.6871	2.0262	2.1287	2.4314	2.7154	2.9853	3.3256
38	0.6810	0.8512	1.0508	1.3042	1.6860	2.0244	2.1267	2.4286	2.7116	2.9803	3.3190
39	0.6808	0.8509	1.0504	1.3036	1.6849	2.0227	2.1247	2.4258	2.7079	2.9756	3.3127
40	0.6807	0.8507	1.0500	1.3031	1.6839	2.0211	2.1229	2.4233	2.7045	2.9712	3.3069
50	0.6794	0.8489	1.0473	1.2987	1.6759	2.0086	2.1087	2.4033	2.6778	2.9370	3.2614
60	0.6786	0.8477	1.0455	1.2958	1.6706	2.0003	2.0994	2.3901	2.6603	2.9146	3.2317
75	0.6778	0.8464	1.0436	1.2929	1.6654	1.9921	2.0901	2.3771	2.6430	2.8924	3.2024
100	0.6770	0.8452	1.0418	1.2901	1.6602	1.9840	2.0809	2.3642	2.6259	2.8707	3.1738
∞	0.6745	0.8416	1.0364	1.2816	1.6449	1.9600	2.0537	2.3263	2.5758	2.8070	3.0902

Quantiles of chi-squared distributions

Percentiles of the chi-square distribution, $P(X^2 \leq \chi^2)$



df	0.005	0.025	0.05	0.8	0.9	0.95	0.975	0.98	0.99	0.995	0.998	0.999
1	3.93E-05	9.82E-04	0.004	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.55	10.828
2	0.01	0.051	0.103	3.219	4.605	5.991	7.378	7.824	9.21	10.597	12.429	13.816
3	0.0717	0.216	0.352	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	0.711	5.989	7.779	9.488	11.143	11.668	13.277	14.86	16.924	18.467
5	0.412	0.831	1.145	7.289	9.236	11.07	12.833	13.388	15.086	16.75	18.907	20.515
6	0.676	1.237	1.635	8.558	10.645	12.592	14.449	15.033	16.812	18.548	20.791	22.458
7	0.989	1.690	2.167	9.803	12.017	14.067	16.013	16.622	18.475	20.278	22.601	24.322
8	1.344	2.180	2.733	11.03	13.362	15.507	17.535	18.168	20.09	21.955	24.352	26.124
9	1.735	2.700	3.325	12.242	14.684	16.919	19.023	19.679	21.666	23.589	26.056	27.877
10	2.156	3.247	3.940	13.442	15.987	18.307	20.483	21.161	23.209	25.188	27.722	29.588
11	2.603	3.816	4.575	14.631	17.275	19.675	21.92	22.618	24.725	26.757	29.354	31.264
12	3.074	4.404	5.226	15.812	18.549	21.026	23.337	24.054	26.217	28.3	30.957	32.909
13	3.565	5.009	5.892	16.985	19.812	22.362	24.736	25.472	27.688	29.819	32.535	34.528
14	4.075	5.629	6.571	18.151	21.064	23.685	26.119	26.873	29.141	31.319	34.091	36.123
15	4.601	6.262	7.261	19.311	22.307	24.996	27.488	28.259	30.578	32.801	35.628	37.697
16	5.142	6.908	7.962	20.465	23.542	26.296	28.845	29.633	32	34.267	37.146	39.252
17	5.697	7.564	8.672	21.615	24.769	27.587	30.191	30.995	33.409	35.718	38.648	40.79
18	6.265	8.231	9.390	22.76	25.989	28.869	31.526	32.346	34.805	37.156	40.136	42.312
19	6.844	8.907	10.117	23.9	27.204	30.144	32.852	33.687	36.191	38.582	41.61	43.82
20	7.434	9.591	10.851	25.038	28.412	31.41	34.17	35.02	37.566	39.997	43.072	45.315
21	8.034	10.283	11.591	26.171	29.615	32.671	35.479	36.343	38.932	41.401	44.522	46.797
22	8.643	10.982	12.338	27.301	30.813	33.924	36.781	37.659	40.289	42.796	45.962	48.268
23	9.26	11.689	13.091	28.429	32.007	35.172	38.076	38.968	41.638	44.181	47.391	49.728
24	9.886	12.401	13.848	29.553	33.196	36.415	39.364	40.27	42.98	45.559	48.812	51.179
25	10.52	13.120	14.611	30.675	34.382	37.652	40.646	41.566	44.314	46.928	50.223	52.62
26	11.16	13.844	15.379	31.795	35.563	38.885	41.923	42.856	45.642	48.29	51.627	54.052
27	11.808	14.573	16.151	32.912	36.741	40.113	43.195	44.14	46.963	49.645	53.023	55.476
28	12.461	15.308	16.928	34.027	37.916	41.337	44.461	45.419	48.278	50.993	54.411	56.892
29	13.121	16.047	17.708	35.139	39.087	42.557	45.722	46.693	49.588	52.336	55.792	58.301
30	13.787	16.791	18.493	36.25	40.256	43.773	46.979	47.962	50.892	53.672	57.167	59.703
31	14.458	17.539	19.281	37.359	41.422	44.985	48.232	49.226	52.191	55.003	58.536	61.098
32	15.134	18.291	20.072	38.466	42.585	46.194	49.48	50.487	53.486	56.328	59.899	62.487
33	15.815	19.047	20.867	39.572	43.745	47.4	50.725	51.743	54.776	57.648	61.256	63.87
34	16.501	19.806	21.664	40.676	44.903	48.602	51.966	52.995	56.061	58.964	62.608	65.247
35	17.192	20.569	22.465	41.778	46.059	49.802	53.203	54.244	57.342	60.275	63.955	66.619
36	17.887	21.336	23.269	42.879	47.212	50.998	54.437	55.489	58.619	61.581	65.296	67.985
37	18.586	22.106	24.075	43.978	48.363	52.192	55.668	56.73	59.893	62.883	66.633	69 346
38	19.289	22.878	24.884	45.076	49.513	53.384	56.896	57.969	61.162	64.181	67.966	70.703
39	19.996	23.654	25.695	46.173	50.66	54.572	58.12	59.204	62.428	65.476	69.294	72.055
40	20.707	24.433	26.509	47.269	51.805	55.758	59.342	60.436	63.691	66.766	70.618	73.402
41	21.421	25.215	27.326	48.363	52.949	56.942	60.561	61.665	64.95	68.053	71.938	74.745
42	22.138	25.999	28.144	49.456	54.09	58.124	61.777	62.892	66.206	69.336	73.254	76.084
43	22.859	26.785	28.965	50.548	55.23	59.304	62.99	64.116	67.459	70.616	74.566	77.419
44	23.584	27.575	29.787	51.639	56.369	60.481	64.201	65.337	68.71	71.893	75.874	78.75
45	24.311	28.366	30.612	52.729	57.505	61.656	65.41	66.555	69.957	73.166	77.179	80.077
46	25.041	29.160	31.439	53.818	58.641	62.83	66.617	67.771	71.201	74.437	78.481	81.4
47	25.775	29.956	32.268	54.906	59.774	64.001	67.821	68.985	72.443	75.704	79.78	82.72
48	26.511	30.755	33.098	55.993	60.907	65.171	69.023	70.197	73.683	76.969	81.075	84.037
49	27.249	31.555	33.930	57.079	62.038	66.339	70.222	71.406	74.919	78.231	82.367	85.351
50	27.991	32.357	34.764	58.164	63.167	67.505	71.42	72.613	76.154	79.49	83.657	86.661
51	28.735	33.162	35.600	59.248	64.295	68.669	72.616	73.818	77.386	80.747	84.943	87.968
52	29.481	33.968	36.437	60.332	65.422	69.832	73.81	75.021	78.616	82.001	86.227	89.272
53	30.23	34.776	37.276	61.414	66.548	70.993	75.002	76.223	79.843	83.253	87.507	90.573
54	30.981	35.586	38.116	62.496	67.673	72.153	76.192	77.422	81.069	84.502	88.786	91.872
55	31.735	36.398	38.958	63.577	68.796	73.311	77.38	78.619	82.292	85.749	90.061	93.168
56	32.49	37.212	39.801	64.658	69.919	74.468	78.567	79.815	83.513	86.994	91.335	94.461
57	33.248	38.027	40.646	65.737	71.04	75.624	79.752	81.009	84.733	88.236	92.605	95.751