École de gestion TELFER School of Management

LIÉE au LINKED with LEADERSHIP

ADM 2304
APPLIED STATISTICAL METHODS IN BUSINESS

February 12, 2011
9:00 – 11:00

NAME (please print): _____

Student Number: _____

SECTION REGISTERED (Circle one):

M N P Q R

Instructions:

Time allowed: Two (2) hours after start of exam.
Length of Exam: 5 pages, plus a 3-page Minitab supplement (please return).
The t-table is behind the Minitab appendices.
Please show all your work and explain your answers briefly where required.
You are encouraged to use the Minitab output as much as possible.
You are permitted to have a non-programmable calculator and a sheet (8.5 x 11 inch) of notes.

Marks: _____ / 10 + _____ / 10 + _____ / 10 + _____ / 10 = _____ / 40

Statement of Academic Integrity

The School of Management does not condone academic fraud, an act by a student that may result in a false academic evaluation of that student or of another student. Without limiting the generality of this definition, academic fraud occurs when a student commits any of the following offences: plagiarism or cheating of any kind, use of books, notes, mathematical tables, dictionaries or other study aid unless an explicit written note to the contrary appears on the exam, to have in his/her possession cameras, radios (radios with head sets), tape recorders, pagers, cell phones, or any other communication device which has not been previously authorized in writing.
I have read the text on academic integrity and I pledge not to have committed or attempted to commit academic fraud in this examination.

Signed: _____

1. [10 marks]

A random sample of high technology stocks was followed over a month to determine whether there has been an overall increase in the price of hi-tech stock prices (from the cost price per share a month ago to the current market price per share). Refer to Appendix A for the data and some possible analyses using Minitab.

a) Without reference to the data distributions but taking into account the manner in which the data were collected, identify two appropriate tests for determining whether there has been an overall increase in prices.

[1]

b) Now look at the boxplots of the data. Which of the two tests above is the most appropriate? Explain briefly with reference to specific boxplots.

[2]

c) Ignoring your answer in (b), perform the most appropriate parametric test to determine if there has been an overall increase in prices. Use the .10 significance level.

[4]

d) Ignoring your answer in (b), perform the most appropriate non-parametric test.

[3]

2. [10 marks]

The Nobel prize winning "monetarist" economist Milton Friedman made a famous but a very controversial assertion that "the social responsibility of business is to increase its profits". Corporate social responsibility has become a hot topic of discussion, and an independent research group has claimed that *at least* 54% of Canadians agree with the Friedman assertion. Since you contend that the proportion is not that high, you take a random sample of 125 people and find only 57 agreeing with the Friedman assertion.

a) Test whether the random sample constitutes sufficient evidence to prove your contention. Use a 5% level of significance.

[4]

b) Calculate an appropriate one-sided (asymmetric) 95% confidence interval. Does your interval disprove the research group's claim? Explain briefly.

[2]

c) Suppose you want to estimate the proportion of Canadians who agree with the Friedman assertion, using a margin of error of ±2% for a 95% symmetric (2-sided) confidence interval. What sample size would be required?

[2]

d) A student took a random sample of 8 other students. She found only one student agreeing with the assertion. If she were testing the hypothesis that the proportion of students agreeing with the assertion is less than 25%, how strong is her evidence against the null hypothesis?

[2]

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3. [10 marks]
The Ministry of Health is extremely concerned about the wait times experienced by patients trying to get into a long term care facility. There is a nominal target of a 90 days wait. A sample of 120 long term care clients was taken and their wait times were calculated. Refer to Appendix B for the Minitab analysis of the data.

a) Test whether there is sufficient evidence that the mean wait time is more than twice the target wait time. Use the .05 level of significance.

[4]

b) What is the p-value for the result in (a)?

[1]

c) Is the test in (a) valid? Explain briefly.

[1]

d) Test whether there is sufficient evidence that the median wait time is less than 180 days. Use the .05 significance level.

[3]

e) A very large sample concluded that the mean wait time was in fact more than twice the target wait time and that the median wait time was in fact less than twice the target wait time. Is this consistent or inconsistent with your results in (a) and (d)? Explain briefly.

[1]

4. [10 marks]
Statistics Canada did a survey of Canadians in 2004 and determined that the average adult female over the age of 18 watches 25.6 hours of television per week while the average male watches 20.9 hours per week. Suppose that the sample comprised 35 females and 50 males (obviously the real samples were much larger) and that the sample standard deviations were 7.2 hours for females and 7 hours for males.

a) Is there sufficient evidence, at the 5% significance level, to show that adult women spend more time watching TV than adult men? What assumptions are required and how would you check them?

[5]

b) Calculate the appropriate confidence interval to confirm the conclusion from (a). What added information does the confidence interval give you?

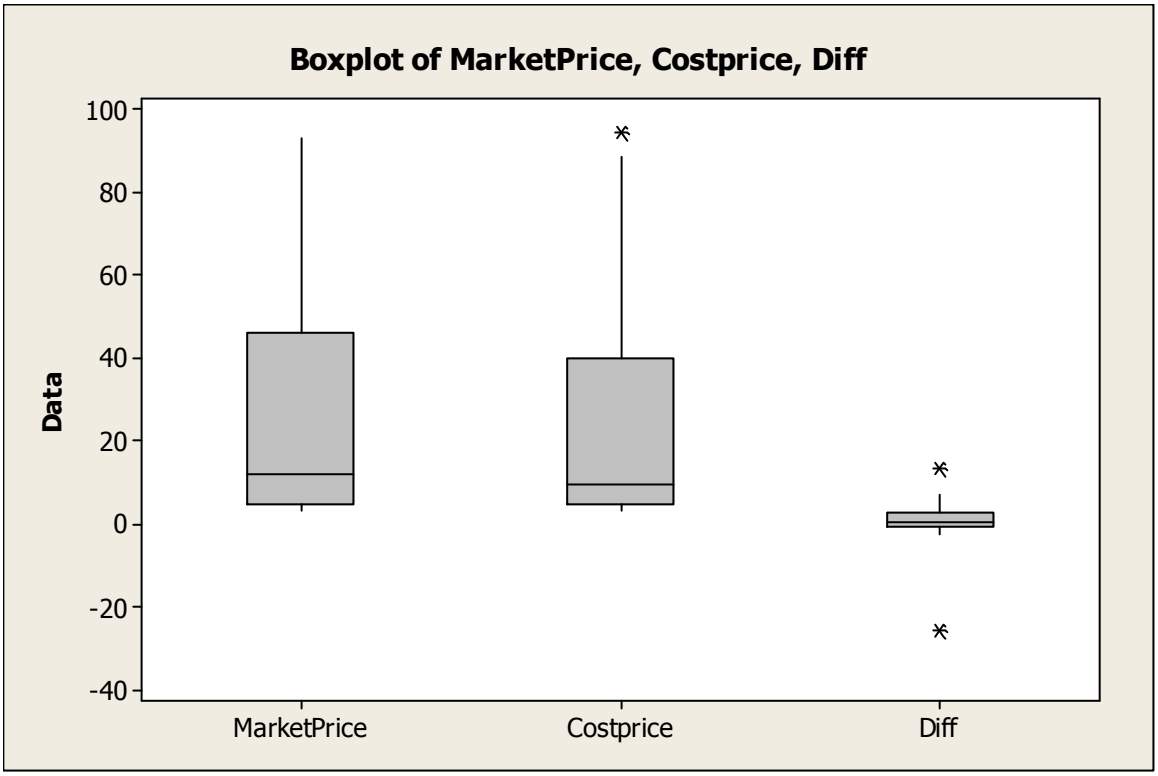
[3]

c) Suppose you were more concerned with detecting a real difference than worrying about attributing a difference when there is none. In this case, would a significance level of 0.10 or 0.01 be more appropriate?

[2]

Appendix A

MarketPrice	Costprice	Diff
63.4	88.96	-25.56
8.92	8.43	0.49
6.12	6.37	-0.25
15.771	11.5	4.271
47.415	44.94	2.475
3.22	3.55	-0.33
93.12	94.44	-1.32
41.624	28.17	13.454
45.95	38.79	7.16
5.41	5.23	0.18
6.05	4.61	1.44
3.68	4.01	-0.33
4.04	6.55	-2.51
23.1	20.44	2.66



Two-Sample T-Test and CI: MarketPrice, Costprice

```
Two-sample T for MarketPrice vs Costprice

              N  Mean  StDev  SE Mean
MarketPrice  14  26.3   27.9      7.5
Costprice    14  26.1   30.8      8.2


Difference = mu (MarketPrice) - mu (Costprice)
Estimate for difference:  0.130714
90% lower bound for difference:
T-Test of difference = 0 (vs >): T-Value = ______P-Value =       DF = 25
```

Boxplot of MarketPrice, Costprice

Paired T-Test and CI: MarketPrice, Costprice

```
Paired T for MarketPrice - Costprice

              N      Mean     StDev   SE Mean
MarketPrice  14   26.2729   27.9076    7.4586
Costprice    14   26.1421   30.8404    8.2425
Difference   14  0.130714  8.446491  2.257420


90% lower bound for mean difference:
T-Test of mean difference = 0 (vs > 0): T-Value = _______  P-Value =
```

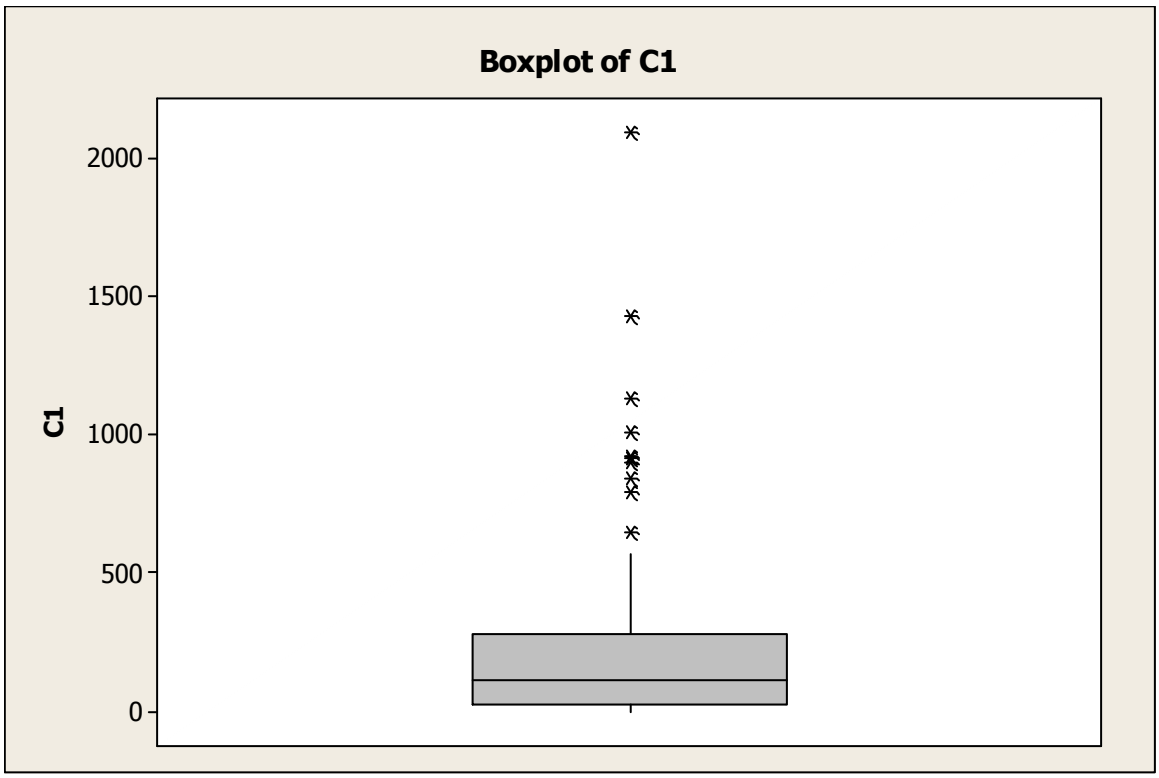
Mann-Whitney Test and CI: MarketPrice, Costprice

```
              N  Median
MarketPrice  14   12.35
Costprice    14    9.97


Point estimate for ETA1-ETA2 is 0.08
90.6 Percent CI for ETA1-ETA2 is (-7.46,12.23)
W = 204.0
Test of ETA1 = ETA2 vs ETA1 > ETA2 is significant at 0.4908
```

Wilcoxon Signed Rank Test: Diff

```
Test of median = 0.000000 versus median > 0.000000

             N
            for   Wilcoxon         Estimated
       N  Test  Statistic      P     Median
Diff  14    14       67.0  0.190     0.8805
```

Appendix B



One-Sample T: C1

```
Test of mu = 180 vs > 180


                                                  95%
                                                Lower
Variable    N     Mean    StDev  SE Mean      Bound     T      P
C1        120  220.892  310.424   28.338
```

Wilcoxon Signed Rank Test: C1

```
Test of median = 180.0 versus median < 180.0

           N
          for   Wilcoxon         Estimated
      N  Test  Statistic      P     Median
C1  120   120     3039.5  0.061      153.3
```

Student's t distribution

t_α

$\alpha = P(t > t_\alpha)$ = one-tail probability

ν	0.100	0.090	0.080	0.070	0.060	0.050	0.025	0.010	0.001	0.0005	0.0001
1	3.08	3.44	3.89	4.47	5.24	6.31	12.71	31.82	318.31	636.62	3183.10
2	1.89	2.03	2.19	2.38	2.62	2.92	4.30	6.96	22.33	31.60	70.70
3	1.64	1.74	1.86	2.00	2.16	2.35	3.18	4.54	10.21	12.92	22.20
4	1.53	1.62	1.72	1.84	1.97	2.13	2.78	3.75	7.17	8.61	13.03
5	1.48	1.56	1.65	1.75	1.87	2.02	2.57	3.36	5.89	6.87	9.68
6	1.44	1.52	1.60	1.70	1.81	1.94	2.45	3.14	5.21	5.96	8.02
7	1.41	1.49	1.57	1.66	1.77	1.89	2.36	3.00	4.79	5.41	7.06
8	1.40	1.47	1.55	1.64	1.74	1.86	2.31	2.90	4.50	5.04	6.44
9	1.38	1.45	1.53	1.62	1.72	1.83	2.26	2.82	4.30	4.78	6.01
10	1.37	1.44	1.52	1.60	1.70	1.81	2.23	2.76	4.14	4.59	5.69
11	1.36	1.43	1.51	1.59	1.69	1.80	2.20	2.72	4.02	4.44	5.45
12	1.36	1.42	1.50	1.58	1.67	1.78	2.18	2.68	3.93	4.32	5.26
13	1.35	1.42	1.49	1.57	1.66	1.77	2.16	2.65	3.85	4.22	5.11
14	1.35	1.41	1.48	1.56	1.66	1.76	2.14	2.62	3.79	4.14	4.99
15	1.34	1.41	1.48	1.56	1.65	1.75	2.13	2.60	3.73	4.07	4.88
16	1.34	1.40	1.47	1.55	1.64	1.75	2.12	2.58	3.69	4.01	4.79
17	1.33	1.40	1.47	1.55	1.64	1.74	2.11	2.57	3.65	3.97	4.71
18	1.33	1.39	1.47	1.54	1.63	1.73	2.10	2.55	3.61	3.92	4.65
19	1.33	1.39	1.46	1.54	1.63	1.73	2.09	2.54	3.58	3.88	4.59
20	1.33	1.39	1.46	1.54	1.62	1.72	2.09	2.53	3.55	3.85	4.54
21	1.32	1.39	1.46	1.53	1.62	1.72	2.08	2.52	3.53	3.82	4.49
22	1.32	1.38	1.45	1.53	1.62	1.72	2.07	2.51	3.50	3.79	4.45
23	1.32	1.38	1.45	1.53	1.61	1.71	2.07	2.50	3.48	3.77	4.42
24	1.32	1.38	1.45	1.53	1.61	1.71	2.06	2.49	3.47	3.75	4.38
25	1.32	1.38	1.45	1.52	1.61	1.71	2.06	2.49	3.45	3.73	4.35
26	1.31	1.38	1.45	1.52	1.61	1.71	2.06	2.48	3.43	3.71	4.32
27	1.31	1.38	1.44	1.52	1.61	1.70	2.05	2.47	3.42	3.69	4.30
28	1.31	1.38	1.44	1.52	1.60	1.70	2.05	2.47	3.41	3.67	4.28
29	1.31	1.37	1.44	1.52	1.60	1.70	2.05	2.46	3.40	3.66	4.25
30	1.31	1.37	1.44	1.52	1.60	1.70	2.04	2.46	3.39	3.65	4.23
31	1.31	1.37	1.44	1.51	1.60	1.70	2.04	2.45	3.37	3.63	4.22
32	1.31	1.37	1.44	1.51	1.60	1.69	2.04	2.45	3.37	3.62	4.20
33	1.31	1.37	1.44	1.51	1.60	1.69	2.03	2.44	3.36	3.61	4.18
34	1.31	1.37	1.44	1.51	1.59	1.69	2.03	2.44	3.35	3.60	4.17
35	1.31	1.37	1.44	1.51	1.59	1.69	2.03	2.44	3.34	3.59	4.15
36	1.31	1.37	1.43	1.51	1.59	1.69	2.03	2.43	3.33	3.58	4.14
37	1.30	1.37	1.43	1.51	1.59	1.69	2.03	2.43	3.33	3.57	4.13
38	1.30	1.37	1.43	1.51	1.59	1.69	2.02	2.43	3.32	3.57	4.12
39	1.30	1.37	1.43	1.51	1.59	1.68	2.02	2.43	3.31	3.56	4.10
40	1.30	1.36	1.43	1.51	1.59	1.68	2.02	2.42	3.31	3.55	4.09
50	1.30	1.36	1.43	1.50	1.58	1.68	2.01	2.40	3.26	3.50	4.01
100	1.29	1.35	1.42	1.49	1.57	1.66	1.98	2.36	3.17	3.39	3.86
200	1.29	1.35	1.41	1.48	1.56	1.65	1.97	2.35	3.13	3.34	3.79
1000	1.28	1.34	1.41	1.48	1.56	1.65	1.96	2.33	3.10	3.30	3.73

Standard Normal Distribution

P(Z < z) (z negative)

Second decimal place in z

0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00	z
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-3.9
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-3.8
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-3.7
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	-3.6
0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	-3.5
0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	-3.4
0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005	-3.3
0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	-3.2
0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010	-3.1
0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	-3.0
0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019	-2.9
0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026	-2.8
0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035	-2.7
0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047	-2.6
0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062	-2.5
0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082	-2.4
0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107	-2.3
0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139	-2.2
0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179	-2.1
0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228	-2.0
0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287	-1.9
0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359	-1.8
0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446	-1.7
0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548	-1.6
0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668	-1.5
0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808	-1.4
0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968	-1.3
0.0985	0.1003	0.1020	0.1038	0.1056	0.1075	0.1093	0.1112	0.1131	0.1151	-1.2
0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357	-1.1
0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587	-1.0
0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841	-0.9
0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119	-0.8
0.2148	0.2177	0.2206	0.2236	0.2266	0.2296	0.2327	0.2358	0.2389	0.2420	-0.7
0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743	-0.6
0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085	-0.5
0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446	-0.4
0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821	-0.3
0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207	-0.2
0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602	-0.1
0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000	0.0

Standard Normal Distribution

P(Z < z) (z positive)

Second decimal place in z

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
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000