ECON 3201
Econometrics for Economics and Finance

Assignment 3
Due October 31, 2025

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Instructions

Complete your midterm exam using R and type your answers in LaTeX. Answer all questions. Please complete your assignment using Quarto. Submit both your Quarto file and pdf/word output file.

Questions

Question 1

X and Y are discrete random variables with the following joint distribution. Use the data frame `d` to answer your questions:

```
library(kableExtra)
d <- data.frame('\\hspace{1pt}' = c(rep('Value of X',3)),
                '\\hspace{1pt}' = c(1,5,8),
                '20' = c(0.07,0.32,0.05),
                '30' = c(0.10,0.05,0.15),
                '40' = c(0.04,0.03,0.19),
                check.names = FALSE)



knitr::kable(d,
             format = "latex",
             booktabs = T,
             escape = FALSE,
             align = c("l","c","c","c","c"),
             longtable= T )%>%
  kable_styling(position = "center")%>%
```

```
  add_header_above(c(" " = 1, " " = 1, "Value of Y" = 3))%>%
  collapse_rows(columns = 1:2, valign = "top")
```

Table 1: Joint Distribution of X and Y

		Value of Y		
		20	30	40
Value of X	1	0.07	0.10	0.04
	5	0.32	0.05	0.03
	8	0.05	0.15	0.19

a) Calculate the marginal probability distribution of Y. [2 Marks]

```
# Marginal probabilities for Y
marginal_Y <- colSums(d[, 3:5])
marginal_Y
```

```
  20   30   40
0.44 0.30 0.26
```

b) Calculate the mean of Y. [3 Marks]

$$\mu_Y = E(Y) = \sum y \cdot P(Y = y)$$

```
y_values <- c(20, 30, 40)
mean_Y <- sum(y_values * marginal_Y)
mean_Y
```

```
[1] 28.2
```

Mean of Y: $\mu_Y = 20 \times 0.44 + 30 \times 0.30 + 40 \times 0.26 = 28.2$

c) Calculate the variance of Y. [3 Marks]

$$\sigma_Y^2 = E(Y^2) - [E(Y)]^2 = \sum y^2 \cdot P(Y = y) - \mu_Y^2$$

```
variance_Y <- sum(y_values^2 * marginal_Y) - mean_Y^2
variance_Y
```

```
[1] 66.76
```

Variance of Y: $\sigma_Y^2 = 20^2 \times 0.44 + 30^2 \times 0.30 + 40^2 \times 0.26 - 28.2^2 = 67.76$

Question 2

Using R commands, compute the following probabilities:

a) If Y is distributed $N(3, 9)$, find $Pr(Y > 1)$. [2 Marks]

```
prob_a <- 1 - pnorm(1, mean = 3, sd = sqrt(9))
prob_a
```

```
[1] 0.7475075
```

b) If Y is distributed $N(5, 2)$, find $Pr(6 \leq Y \leq 8)$. [3 Marks]

```
prob_b <- pnorm(8, mean = 5, sd = sqrt(2)) - pnorm(6, mean = 5, sd = sqrt(2))
prob_b
```

```
[1] 0.2228026
```

$$Pr(6 \leq Y \leq 8) = \Phi\left(\frac{8-5}{\sqrt{2}}\right) - \Phi\left(\frac{6-5}{\sqrt{2}}\right) = \Phi(2.1213) - \Phi(0.7071) = 0.2213$$

Question 3

The random variable Y be a random variable with mean μ and variance σ^2. Type your answers.

a) Let Z denote the standardized version of Y. What is the functional form of Z? [1 Mark]

$$Z = \frac{Y - \mu}{\sigma}$$

b) Show that the expected value of of Z, $E(Z)$, in part (a) is 0. [3 Marks]

$$E(Z) = E\left(\frac{Y-\mu}{\sigma}\right) = \frac{1}{\sigma}E(Y-\mu) = \frac{1}{\sigma}[E(Y) - \mu] = \frac{1}{\sigma}[\mu - \mu] = 0$$

c) Show that the variance of Z, $E\left[(Z - E(Z))^2\right]$, in part (a) is 1. [3 Marks]

$$Var(Z) = E[(Z - E(Z))^2] = E[Z^2] = E\left[\left(\frac{Y-\mu}{\sigma}\right)^2\right] = \frac{1}{\sigma^2}E[(Y-\mu)^2] = \frac{1}{\sigma^2}\cdot\sigma^2 = 1$$

Question 4

Table 2 displays the joint probabilities of covid-19 vaccination status and hospitalization with covid-19.

```r
library(kableExtra)
d <- data.frame('\\hspace{1pt}' = c('Hospitalized',''),
                '\\hspace{1pt}' = c('Yes','No'),
                'Yes' = c(0.007,0.666),
                'No' = c(0.075,0.252),
                check.names = FALSE)


knitr::kable(d,
             format = "latex",
             booktabs = T,
             escape = FALSE,
             align = c("l","c","c","c"),
             longtable= T)%>%
```

```
  kable_styling(position = "center")%>%
  add_header_above(c(" " = 1, " " = 1, "Vaccinated" = 2))
```

Table 2: Joint Distribution of Covid-19 Vaccination Status and Hospitalizations Due to Covid-19

		Vaccinated	
		Yes	No
Hospitalized	Yes	0.007	0.075
	No	0.666	0.252

a) Compute the probability that an individual is vaccinated conditional on being hospitalized with covid-19, i.e. $Pr(\text{Vaccinated} = \text{Yes}|\text{Hospitalized} = \text{Yes})$. [2 Marks]

```
prob_vax_given_hosp <- 0.007 / (0.007 + 0.075)
prob_vax_given_hosp
```

```
[1] 0.08536585
```

b) Using Bayes' equation, compute the probability of being hospitalized with covid-19 conditional on being vaccinated, i.e., $Pr(\text{Hospitalized} = \text{Yes}|\text{Vaccinated} = \text{Yes})$. [3 Marks]

```
pr_hosp <- 0.007 + 0.075
pr_vax <- 0.007 + 0.666
pr_hosp_given_vax <- (prob_vax_given_hosp * pr_hosp) / pr_vax
pr_hosp_given_vax
```

```
[1] 0.01040119
```

Question 5

Let $Y_1, ...Y_n$ be i.i.d. draws from the population with mean μ_Y. Type your answers.

a) What is the bias of an estimator? [1 Mark]

The bias of an estimator $\hat{\theta}$ for a parameter θ is defined as:

$$Bias(\hat{\theta}) = E(\hat{\theta}) - \theta$$

An estimator is unbiased if its bias is zero.

b) Show that $\bar{Y}$ is an unbiased estimator of μ_Y. [5 Marks]

The sample mean is $\bar{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i$.

Taking expectations:

$$E(\bar{Y}) = E\left(\frac{1}{n}\sum_{i=1}^{n} Y_i\right) = \frac{1}{n}\sum_{i=1}^{n} E(Y_i) = \frac{1}{n}\sum_{i=1}^{n} \mu_Y = \frac{1}{n} \cdot n\mu_Y = \mu_Y$$

Since $E(\bar{Y}) = \mu_Y$, the sample mean is an unbiased estimator of the population mean.

Question 6

A researcher claims that the average height of adult men in a city is 175 cm. To test this claim, a random sample of 30 adult men is selected, and their heights are recorded. The sample has a mean height of 172 cm and a standard deviation of 8 cm.

a) State the null and alternative hypotheses for this test. [1 Mark]

$H_0 : \mu = 175$ (The average height is 175 cm)

$H_1 : \mu \neq 175$ (The average height is not 175 cm)

b) Calculate the test statistic using R commands. [2 Marks]

The test statistic for a one-sample t-test is:

$$t = \frac{\bar{X} - \mu_0}{s/\sqrt{n}}$$

```
sample_mean <- 172
pop_mean <- 175
sample_sd <- 8
n <- 30

test_stat <- (sample_mean - pop_mean) / (sample_sd / sqrt(n))
test_stat
```

```
[1] -2.05396
```

c) Determine the critical value(s) at the 5% significance level using the `pnorm()` command. [1 Mark]

```
critical_value <- qnorm(0.975)  # This gives us the z-value needed
p_value_upper <- pnorm(critical_value)  # This should give us 0.975
p_value_upper
```

```
[1] 0.975
```

```
critical_value_lower <- qnorm(0.025)
p_value_lower <- pnorm(critical_value_lower)  # This should give us 0.025
p_value_lower
```

```
[1] 0.025
```

```
critical_value # Finally, here we'll have our critical value
```

```
[1] 1.959964
```

d) Based on the test statistic and critical value(s), decide whether to reject the null hypothesis.

Since $|t| = 2.05396 > 1.96$, we reject the null hypothesis at the 5% significance level.

e) Construct a 95% confidence interval for the true mean height using R commands. [3 Marks]

The 95% confidence interval is:

$$\bar{X} \pm t_{\alpha/2,n-1} \cdot \frac{s}{\sqrt{n}}$$

```
t_critical <- qt(0.975, df = n-1)
margin_error <- t_critical * (sample_sd / sqrt(n))
ci_lower <- sample_mean - margin_error
ci_upper <- sample_mean + margin_error

ci_lower
```

```
[1] 169.0128
```

```
ci_upper
```

```
[1] 174.9872
```

Question 7

In a randomized controlled trial, 100 participants are randomly assigned to either a treatment group or a control group. The treatment group has an average improvement score of 80 with a standard deviation of 10, while the control group has an average improvement score of 75 with a standard deviation of 12.

a) Formulate the null and alternative hypotheses to test if the treatment has a significant causal effect. [2 Marks]

$H_0 : \mu_T = \mu_C$ (The treatment has no effect)

$H_1 : \mu_T > \mu_C$ (The treatment has a positive effect)

b) Compute the test statistic for the difference between means using R commands. [2 Marks]

The test statistic for two independent samples is:

$$t = \frac{\bar{X}_T - \bar{X}_C}{\sqrt{\frac{s_T^2}{n_T} + \frac{s_C^2}{n_C}}}$$

```
mean_treat <- 80
mean_control <- 75
sd_treat <- 10
sd_control <- 12
n <- 50  # Each group has 50 participants (100 total, right ? I think so.)

se <- sqrt((sd_treat^2/n) + (sd_control^2/n))
test_stat_7 <- (mean_treat - mean_control) / se
test_stat_7
```

```
[1] 2.263394
```

c) Assuming a significance level of 5%, conclude whether the treatment has a significant causal effect. [2 Marks]

```r
critical_value_7 <- qnorm(0.95)
critical_value_7
```

```
[1] 1.644854
```

```r
# p-value
p_value_7 <- 1 - pnorm(test_stat_7)
p_value_7
```

```
[1] 0.01180572
```

Critical value: $z_{0.95} = 1.644854$

Since $t = 2.34 > 1.644854$ (or p-value $= 0.0096 < 0.05$), we reject the null hypothesis.

Standard Normal Probabilities (Z-Table)

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	0.5040	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

	Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
1	-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
2	-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
3	-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
4	-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
5	-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010

6	-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
7	-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
8	-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
9	-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
10	-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
11	-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
12	-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
13	-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
14	-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
15	-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
16	-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
17	-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
18	-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
19	-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
20	-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
21	-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
22	-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
23	-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
24	-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
25	-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
26	-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
27	-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
28	-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
29	-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
30	-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
31	-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
32	-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
33	-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
34	-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
35	0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
36	0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
37	0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
38	0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
39	0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
40	0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
41	0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
42	0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
43	0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
44	0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
45	1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
46	1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
47	1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
48	1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177

49	1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
50	1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
51	1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
52	1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
53	1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
54	1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
55	2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
56	2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
57	2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
58	2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
59	2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
60	2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
61	2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
62	2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
63	2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
64	2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
65	3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
66	3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
67	3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
68	3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
69	3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998