PGDM 15-17

Statistics for Business Analysis

DM-107

Trimester-I, End-Term Examination: September 2015

Time allowed: 2 hrs 30 min **Max marks: 50**

Roll No: ____________

This paper contains 5 pages, and three sections.
Please show all workings clearly. Calculators may be used. Required tables and some formulae have been provided at the end of this question booklet. A correct answer may not fetch credit unless backed by step-by-step working.

Section A

Attempt ANY 3 questions from the 5 questions in this section. (3 x 5)

A1. In what way may an estimate be less meaningful because of

(a) A high confidence level?

(b) A narrow confidence interval?

A2. The following sample of eight observations is from an infinite population with a normal distribution: 75.3 76.4 83.2 91.0 80.1 77.5 84.8 81.0

(a) Find the sample mean.

(b) Estimate the population standard deviation.

(c) Construct a 98% confidence interval for the population mean.

$$\left[\sum_{i=1}^{8} x_i = 649.3 \quad \sum_{i=1}^{8} x_i^2 = 52884.59 \right]$$

A3. The registrar for a university system needs to know what proportion of students have GPA < 2.0. How many students' grades should be looked at in order to determine this proportion to within ± 0.01 with a 95% confidence?

A4. If our goal is to accept a null hypothesis that $\mu = 36.5$ with 96% certainty when it is true, and our sample size is 50, diagram the acceptance and rejection regions for the following alternative hypothesis:

(a) $\mu \neq 36.5$

(b) $\mu < 36.5$

A5. Your null hypothesis is that the battery for a heart pacemaker has an average life of 300 days, with the alternative hypothesis being that the battery life is more than 300 days. You are the quality control engineer for the battery manufacturer.

(a) Would you rather make a Type I or a Type II error? Why?

(b) Based on your answer to part (a), should you use a high or a low significance level (α)? Justify.

Section B

Attempt ANY 2 questions from the 3 questions in this section. (2 x 10)

B1. The Government Accounting Office (GAO) is interested in seeing whether similar-sized offices spend similar amounts on personnel and equipment. (Offices spending more are targeted for special auditing.) Monthly expenses for three offices have been examined: one office each in the Agricultural Depertment, State Department and Interior Department. The data follow. At the 0.05 significance level, are there differences in expenses for the different offices?

Monthly Office Expenses ($ thousands) for some past months						
Agriculture	10	8	11	9	12	
State	15	9	8	10	13	13
Interior	8	16	12			

Summary Statistics:

Value	*Group*			
	Agriculture	*State*	*Interior*	*All*
$\sum X_{group}$	*50*	*68*	*36*	*154*
$\sum X^2_{group}$	*510*	*808*	*464*	*1782*

B2. An advertising firm is trying to determine the demographics for a new product. They have randomly selected 75 people in each of 5 different age groups and introduced the product to them. The results of the survey are given in the following table:

	Age Group				
Future Activity	**18-29**	**30-39**	**40-49**	**50-59**	**60-69**
Purchase frequently	12	18	17	22	32
Seldom purchase	18	25	29	24	30
Never purchase	45	32	29	29	13

(a) Calculate the sample χ^2 value.
(b) State the null and the alternative hypotheses.
(c) If the level of significance is 0.01, should the null hypothesis be rejected? (Sketch the sampling distribution, along with the test statistic and the critical region.)

B3. Realtors are often interested in seeing how the appraised value of a home varies according to the size of the home. Some data on area (in thousands of square feet) and appraised value (in thousands of dollars) for a sample of 11 homes follow.

Area	1.1	1.5	1.6	1.6	1.4	1.3	1.1	1.7	1.9	1.5	1.3
Value	75	95	110	102	95	87	82	115	122	98	90

(a) Estimate the least-squares regression to predict appraised value from size.
(b) Calculate the standard error of the estimate, s_e, for these data.
(c) Calculate the sample coefficient of detremination, r^2, for these data.

Summary Statistics:

$\sum$ *Area*	$\sum$ *Value*	$\sum$ *Area*^{2}	$\sum$ *Value*^{2}	$\sum$ *Area* $\times$ *Value*
16	*1071*	*23.88*	*106285*	*1591.8*

Section C

(1 x 15)

C1. Feronetics specializes in the use of gene-splicing techniques to produce new pharmaceutical compounds. It has recently developed a nasal spray containing *interferon*, which it believes will limit the transmission of the common cold within families. In the general population, 15.1% of all individuals will catch a rhinovirus-caused cold once another family member contracts such a cold. The interferon spray was tested on 180 people, one of whose family members subsequently contracted a rhinovirus-caused cold. Only 17 of the test subjects developed similar colds.

(a) At a significance level of 0.05, should Feronetics conclude that the new spray effectively reduces transmission of colds?

(b) What should it conclude at $\alpha = 0.02$?

(c) On the basis of these results do you think Feronetics should be allowed to market the new spray? Explain.

Tables

F Table (Percentage point of F-Distribution (α=0.05)

Numerator Degrees of Freedom (Numerator DF)

Denominator Degrees of Freedom	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	Inf.
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88	243.91	245.95	248.01	249.05	250.10	251.14	252.20	253.25	254.25
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.37
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.41
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.85
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.82
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.79
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.74
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.68
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.66
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.63
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.26
Inf.	3.84	3.00	2.61	2.37	2.22	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.40	1.32	1.22	1.05

Standard Normal Cumulative Probability Table

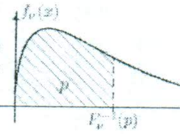
Cumulative probabilities for NEGATIVE z-values are shown in the following table:

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	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

5 χ^2 distribution

Inverse $F_\nu^{-1}(p)$ of the cumulative distribution function (quantiles)

The table below contains the quantiles of the χ^2 (chi-squared) distribution with ν degrees of freedom. For $0 < p < 1$ the quantile is the value of x for which $P\{X \le x\} = p$, where $X \sim \chi^2(\nu)$. Thus $x = F_\nu^{-1}(p)$.

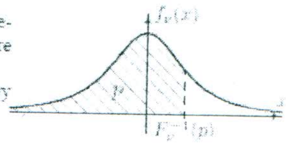


ν \ p	0.005	0.01	0.025	0.05	0.1	0.5	0.9	0.95	0.975	0.99	0.995	0.999
1	0.0000	0.0002	0.0010	0.0039	0.0158	0.4549	2.7055	3.8415	5.0239	6.6349	7.8794	10.828
2	0.0100	0.0201	0.0506	0.1026	0.2107	1.3863	4.6052	5.9915	7.3778	9.2103	10.597	13.816
3	0.0717	0.1148	0.2158	0.3518	0.5844	2.3660	6.2514	7.8147	9.3484	11.345	12.838	16.266
4	0.2070	0.2971	0.4844	0.7107	1.0636	3.3567	7.7794	9.4877	11.143	13.277	14.860	18.467
5	0.4117	0.5543	0.8312	1.1455	1.6103	4.3515	9.2364	11.070	12.833	15.086	16.750	20.515
6	0.6757	0.8721	1.2373	1.6354	2.2041	5.3481	10.645	12.592	14.449	16.812	18.548	22.458
7	0.9893	1.2390	1.6899	2.1673	2.8331	6.3458	12.017	14.067	16.013	18.475	20.278	24.322
8	1.3444	1.6465	2.1797	2.7326	3.4895	7.3441	13.362	15.507	17.535	20.090	21.955	26.124
9	1.7349	2.0879	2.7004	3.3251	4.1682	8.3428	14.684	16.919	19.023	21.666	23.589	27.877
10	2.1559	2.5582	3.2470	3.9403	4.8652	9.3418	15.987	18.307	20.483	23.209	25.188	29.588
11	2.6032	3.0535	3.8157	4.5748	5.5778	10.341	17.275	19.675	21.920	24.725	26.757	31.264
12	3.0738	3.5706	4.4038	5.2260	6.3038	11.340	18.549	21.026	23.337	26.217	28.300	32.909
13	3.5650	4.1069	5.0088	5.8919	7.0415	12.340	19.812	22.362	24.736	27.688	29.819	34.528
14	4.0747	4.6604	5.6287	6.5706	7.7895	13.339	21.064	23.685	26.119	29.141	31.319	36.123
15	4.6009	5.2293	6.2621	7.2609	8.5468	14.339	22.307	24.996	27.488	30.578	32.801	37.697
16	5.1422	5.8122	6.9077	7.9616	9.3122	15.338	23.542	26.296	28.845	32.000	34.267	39.252
17	5.6972	6.4078	7.5642	8.6718	10.085	16.338	24.769	27.587	30.191	33.409	35.718	40.790
18	6.2648	7.0149	8.2307	9.3905	10.865	17.338	25.989	28.869	31.526	34.805	37.156	42.312
19	6.8440	7.6327	8.9065	10.117	11.651	18.338	27.204	30.144	32.852	36.191	38.582	43.820
20	7.4338	8.2604	9.5908	10.851	12.443	19.337	28.412	31.410	34.170	37.566	39.997	45.315
21	8.0337	8.8972	10.283	11.591	13.240	20.337	29.615	32.671	35.479	38.932	41.401	46.797
22	8.6427	9.5425	10.982	12.338	14.041	21.337	30.813	33.924	36.781	40.289	42.796	48.268
23	9.2604	10.196	11.689	13.091	14.848	22.337	32.007	35.172	38.076	41.638	44.181	49.728
24	9.8862	10.856	12.401	13.848	15.659	23.337	33.196	36.415	39.364	42.980	45.559	51.179
25	10.520	11.524	13.120	14.611	16.473	24.337	34.382	37.652	40.646	44.314	46.928	52.620
26	11.160	12.198	13.844	15.379	17.292	25.336	35.563	38.885	41.923	45.642	48.290	54.052
27	11.808	12.879	14.573	16.151	18.114	26.336	36.741	40.113	43.195	46.963	49.645	55.476
28	12.461	13.565	15.308	16.928	18.939	27.336	37.916	41.337	44.461	48.278	50.993	56.892
29	13.121	14.256	16.047	17.708	19.768	28.336	39.087	42.557	45.722	49.588	52.336	58.301
30	13.787	14.953	16.791	18.493	20.599	29.336	40.256	43.773	46.979	50.892	53.672	59.703

4 Student's t distribution

Inverse $F_\nu^{-1}(p)$ of the cumulative distribution function (quantiles)

The table below contains the quantiles of Student's t distribution with ν degrees of freedom. For $0 < p < 1$ the quantile is the value of x for which $P\{X \leq x\} = p$, where $X \sim t(\nu)$. Thus $x = F_\nu^{-1}(p)$.
The table only contains the quantiles for $p \geq \frac{1}{2}$. For $p < \frac{1}{2}$ quantiles can be obtained by exploiting the symmetry of the t distribution: $F_\nu^{-1}(p) = -F_\nu^{-1}(1-p)$.



ν	0.6	0.7	0.75	0.8	0.85	0.9	0.95	0.975	0.99	0.995	0.999	0.9995
1	0.3249	0.7265	1.0000	1.3764	1.9626	3.0777	6.3138	12.706	31.821	63.657	318.31	636.62
2	0.2887	0.6172	0.8165	1.0607	1.3862	1.8856	2.9200	4.3027	6.9646	9.9248	22.327	31.599
3	0.2767	0.5844	0.7649	0.9785	1.2498	1.6377	2.3534	3.1824	4.5407	5.8409	10.215	12.924
4	0.2707	0.5686	0.7407	0.9410	1.1896	1.5332	2.1318	2.7764	3.7469	4.6041	7.1732	8.6103
5	0.2672	0.5594	0.7267	0.9195	1.1558	1.4759	2.0150	2.5706	3.3649	4.0321	5.8934	6.8688
6	0.2648	0.5534	0.7176	0.9057	1.1342	1.4398	1.9432	2.4469	3.1427	3.7074	5.2076	5.9588
7	0.2632	0.5491	0.7111	0.8960	1.1192	1.4149	1.8946	2.3646	2.9980	3.4995	4.7853	5.4079
8	0.2619	0.5459	0.7064	0.8889	1.1081	1.3968	1.8595	2.3060	2.8965	3.3554	4.5008	5.0413
9	0.2610	0.5435	0.7027	0.8834	1.0997	1.3830	1.8331	2.2622	2.8214	3.2498	4.2968	4.7809
10	0.2602	0.5415	0.6998	0.8791	1.0931	1.3722	1.8125	2.2281	2.7638	3.1693	4.1437	4.5869
11	0.2596	0.5399	0.6974	0.8755	1.0877	1.3634	1.7959	2.2010	2.7181	3.1058	4.0247	4.4370
12	0.2590	0.5386	0.6955	0.8726	1.0832	1.3562	1.7823	2.1788	2.6810	3.0545	3.9296	4.3178
13	0.2586	0.5375	0.6938	0.8702	1.0795	1.3502	1.7709	2.1604	2.6503	3.0123	3.8520	4.2208
14	0.2582	0.5366	0.6924	0.8681	1.0763	1.3450	1.7613	2.1448	2.6245	2.9768	3.7874	4.1405
15	0.2579	0.5357	0.6912	0.8662	1.0735	1.3406	1.7531	2.1314	2.6025	2.9467	3.7328	4.0728
16	0.2576	0.5350	0.6901	0.8647	1.0711	1.3368	1.7459	2.1199	2.5835	2.9208	3.6862	4.0150
17	0.2573	0.5344	0.6892	0.8633	1.0690	1.3334	1.7396	2.1098	2.5669	2.8982	3.6458	3.9651
18	0.2571	0.5338	0.6884	0.8620	1.0672	1.3304	1.7341	2.1009	2.5524	2.8784	3.6105	3.9216
19	0.2569	0.5333	0.6876	0.8610	1.0655	1.3277	1.7291	2.0930	2.5395	2.8609	3.5794	3.8834
20	0.2567	0.5329	0.6870	0.8600	1.0640	1.3253	1.7247	2.0860	2.5280	2.8453	3.5518	3.8495
21	0.2566	0.5325	0.6864	0.8591	1.0627	1.3232	1.7207	2.0796	2.5176	2.8314	3.5272	3.8193
22	0.2564	0.5321	0.6858	0.8583	1.0614	1.3212	1.7171	2.0739	2.5083	2.8188	3.5050	3.7921
23	0.2563	0.5317	0.6853	0.8575	1.0603	1.3195	1.7139	2.0687	2.4999	2.8073	3.4850	3.7676
24	0.2562	0.5314	0.6848	0.8569	1.0593	1.3178	1.7109	2.0639	2.4922	2.7969	3.4668	3.7454
25	0.2561	0.5312	0.6844	0.8562	1.0584	1.3163	1.7081	2.0595	2.4851	2.7874	3.4502	3.7251
26	0.2560	0.5309	0.6840	0.8557	1.0575	1.3150	1.7056	2.0555	2.4786	2.7787	3.4350	3.7066
27	0.2559	0.5306	0.6837	0.8551	1.0567	1.3137	1.7033	2.0518	2.4727	2.7707	3.4210	3.6896
28	0.2558	0.5304	0.6834	0.8546	1.0560	1.3125	1.7011	2.0484	2.4671	2.7633	3.4082	3.6739
29	0.2557	0.5302	0.6830	0.8542	1.0553	1.3114	1.6991	2.0452	2.4620	2.7564	3.3962	3.6594
30	0.2556	0.5300	0.6828	0.8538	1.0547	1.3104	1.6973	2.0423	2.4573	2.7500	3.3852	3.6460
31	0.2555	0.5298	0.6825	0.8534	1.0541	1.3095	1.6955	2.0395	2.4528	2.7440	3.3749	3.6335

Formulae etc.

$$b = \frac{\sum XY - n\bar{X}\bar{Y}}{\sum X^2 - n\bar{X}^2} \qquad a = \bar{Y} - b\bar{X} \qquad s_e = \sqrt{\frac{\sum(Y-\hat{Y})^2}{n-2}}$$

$$s_e = \sqrt{\frac{\sum Y^2 - a\sum Y - b\sum XY}{n-2}} \qquad s = \frac{1}{n-1}\sum(X_i - \bar{X})^2 \qquad \sum(X_i-\bar{X})^2 = \sum X_i^2 - n\bar{X}^2$$

$$\chi^2_{(r-1)(c-1)} = \sum \frac{(f_o - f_e)^2}{f_e} \qquad X \sim Poi(\lambda); P(r) = e^{-\lambda}\frac{\lambda^r}{r!} \qquad \sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}\sqrt{\frac{N-n}{N-1}}$$

ANOVA

SV	SS	d.f.	MSS	F-ratio
Between Groups	k-1	SS_B	$MS_B = \frac{SS_B}{k-1}$	$F_{k-1,n-k} = \frac{MS_B}{MS_W}$
Within Groups	n-k	SS_W	$MS_W = \frac{SS_W}{n-k}$	
Total Variation	n-1	SS_T		

$$SS_T = SS_B + SS_W$$

$$F = \frac{\hat{\sigma}_B^2}{\hat{\sigma}_W^2} \qquad \bar{X} \pm z_{\alpha/2}\frac{\hat{\sigma}}{\sqrt{n}}$$

$$1 - \frac{\sum(Y-\hat{Y})^2}{\sum(Y-\bar{Y})^2} = 1 - \frac{\sum Error^2}{SS_T} \qquad \sigma_{\bar{p}} = \sqrt{\frac{pq}{n}}$$