**Stat 2300 International, Fall 2005 – Final**

Monday, December 12, 2005

**Your Name: _____**

**Your CyberStats ID: _____**

The Final consists of 40 questions: 20 multiple-choice questions (with exactly 1 correct answer) and 20 text-based questions where you have to provide a verbal explanation or calculate one or multiple numerical values. Some of the questions require you to use WebStat or any of the interactivities from within CyberStats. You have to decide yourself which of these tools you may have to use.

The exam is worth a total of **500 points**. The number of points for each question is indicated in parentheses at the beginning of each question. You have approximately **120 minutes** to complete the exam. Try to correctly answer as many questions as possible during this time period. **You are allowed to answer questions in any order.** Start with a question that seems the easiest for you. If you cannot answer a question within a short time, move to another question, and come back to the previously unanswered questions toward the end of the exam.

Mark your answers to the multiple choice questions and fill in the spaces for the text-based questions on the **answer sheets**. Do not write your answers on the pages with the questions. However, you can use those pages for personal comments and calculations. Make sure to write your name and your CyberStats ID on the pages with the questions **and** on the answer sheets. You have to turn in the pages with the questions **and** the answer sheets.

For multiple choice questions, mark exactly one of the choices (representing options a, b, c, or d) with a solid dot. Only 1 answer is correct. If you mark more than 1 of the options, this will automatically be an incorrect answer (even if one of the options you have marked is correct). For the text-based questions, indicate the formula you are using, the numerical values you have to fill in, and the final result (e.g., $n*p = 10*0.2 = 2$). Just the (correct) final result will not provide you with the full points for this question. If you use CyberStats to calculate a result, indicate which tool (e.g., binomial calculator) and the result from within CyberStats. Please do not write outside the text boxes.

In case of any problems with CyberStats, please inform your local instructor as quickly as possible and try to answer the questions as far as possible. Return to these questions later on. In case CyberStats is unavailable for an extended time period, your exam score will be adjusted accordingly.

**1.** (10 Points) GPA scores for 100 individuals range from 2.0 to 4.0. Half the individuals have GPA scores around 3.0, a quarter have GPA scores near 2.0, and the rest have GPA scores near 4.0.

The range of the GPA scores is about:

**a.** Exactly 0.0.
**b.** Bigger than 0.0 and less than 1.0.
**c.** About 2.0.
**d.** More than 300.

**2.** (10 Points) Two dice are thrown. Suppose that the sample space is given by the 36 outcomes { (1,1), (1,2), (1,3), (1,4), (1,5), (1,6), (2,1), ... }.

Consider the random variable given by the SUM of the dots showing on the uppermost faces of the dice. Call this random variable *X*.

Which of the following statements is **false**?

**a.** P(1) = 0.
**b.** *P*(7) = 6/36.
**c.** P(11) = 3/36.
**d.** *P*(12) = 1/36.

**3.** (10 Points) A life insurance company is determining the mean payout per policy for $40,000 life insurance policies on 50 year old women. These policies have an accidental death benefit that pays beneficiaries twice the policy amount when the death is accidental. The probability is 27/10,000 that a 50 year old woman dies from natural causes during the year she is 50, and the probability is 1/10,000 that she dies from accidental causes during that year.

| *X* | 0 | $40,000 | $80,000 |
|---|---|---|---|
| Pr(*X*) | 9,972/10,000 | 27/10,000 | 1/10,000 |

What is the expected value of the mean amount paid out?

**a.** $108
**b.** $116
**c.** $232
**d.** $464

**4.** (10 Points) A machine produces parts. The probability that an individual part is defective is .01. If a random sample of 5 parts contains one or more defective parts, the machine is shut down for repairs.

What is the probability that the machine will be shut down for repairs based on one sample of 5 parts?

**a.** 0.0100
**b.** 0.0478
**c.** 0.0490
**d.** 0.0956

**5.** (10 Points) In a partnership, two members decide to make business decisions independently of each other, then compare their conclusions. If they agree, the decision is made to proceed. Partner A makes the right decision 70% of the time and partner B makes the right decision 65% of the time.

What is the probability that **none** of them makes the **right** decision?

**a.** 10.5%
**b.** 54.5%
**c.** 45.5%
**d.** 89.5%

**6.** (10 Points) Three of the following statements are true, while one statement is false.

Which one of the following statements is **false**?

**a.** Results from a convenience sample (such as people voluntarily expressing their opinions on a Web site) cannot be used to calculate a 90% confidence interval for a population mean representing all Americans.
**b.** For data that approximately follow a normal distribution, about 68% of the individual observations can be found within 2 standard deviations of the average.
**c.** A sample mean is an unbiased estimator of a population mean.
**d.** A symmetric sampling distribution occurs if the possible values of the statistic spread out in the same pattern on both sides of the distribution's center.

**7.** (10 Points) The average GPA of all students at a particular university is 3.2. The average GPA of a sample of 38 students from this university is 2.9.

Which value is a statistic?

**a.** 2.9
**b.** 3.2
**c.** 38 students from this university.
**d.** All of the above.

**8.** (10 Points) The table below contains data on the income level and college graduation status of 79 people.

| | Low income | High income | Total |
|---|---|---|---|
| College grad | 13 | 34 | 47 |
| Not college grad | 26 | 6 | 32 |
| Total | 39 | 40 | 79 |

What is the odds ratio for a person having high income when the person **has** graduated from college versus when the person **has not** graduated from college?

**a.** 2:1
**b.** 11.33
**c.** 34:6
**d.** 1:11.33

**9.** (10 Points) Suppose that you suspect that good performance in a first college level mathematics course is related to whether or not a student has taken a complete high school algebra sequence of courses. You have received the following data:

| | High School Preparation? | | |
|---|---|---|---|
| Grade | Algebra Background | No Algebra Background | Total |
| A, B, C | 43 | 31 | 74 |
| D, F | 2 | 9 | 11 |
| Total | 45 | 40 | 85 |

Given that a student has no algebra background, what is the probability of a student receiving a grade of a "A, B, C"?

**a.** About 0.20
**b.** About 1.23
**c.** About 0.87
**d.** About 0.78

**10.** (10 Points) The table below contains data on the income level and college graduation status of 79 people.

| | Low income | High income | Total |
|---|---|---|---|
| College grad | 13 | 34 | 47 |
| Not college grad | 26 | 6 | 32 |
| Total | 39 | 40 | 79 |

If these variables are independent, what is the expected cell count for the upper left cell?

**a.** About 13.0
**b.** About 16.2
**c.** About 23.2
**d.** About 0.59

**11.** (10 points) Which of the following would not be considered a characteristic of a confidence interval?

**a.** A confidence interval can be created for any population parameter.
**b.** The confidence level is usually reported as a percentage.
**c.** Common confidence levels are 90%, 95% and 99%.
**d.** A confidence interval consists of the following critical parts: the lower value, upper value, confidence level and population parameter.

**12.** (10 points) Below are recommendations for the design of good statistical graphics, based on the book chapters by Bowerman and Tufte.

Which of the following recommendations is not given in these chapters:

**a.** One should avoid to have line graphs start far above 0.
**b.** One should not change the scale of the horizontal axis in the middle of a graphic.
**c.** One should not change the scale of the vertical axis in the middle of a graphic.
**d.** One should avoid varying both dimensions simultaneously when area is used to represent one-dimensional data.

**13.** (10 points) What method is appropriate to minimize the width of a confidence interval?

**a.** Maximizing the confidence level.
**b.** Minimizing the confidence level.
**c.** Maximizing the sample standard deviation.
**d.** Minimizing the sample size.

**14.** (10 points) An ESP experiment involving 100 people guessing the suits of 32 regular playing cards was conducted. The number of correct guesses was recorded. Since there are four suits, a person guessing randomly would be expected to guess 32/4 = 8 correctly. The sample mean was 7.8 and the sample standard deviation was 2.51. The null hypothesis is that people do neither better nor worse than if they were guessing randomly.

The null hypothesis specifies that:

**a.** The population mean is 7.8.
**b.** The population mean is 8.
**c.** The sample mean is greater than 8.
**d.** The sample mean is equal to 8.

**15.** (10 points) A coin is tossed 10,000 times to see if it is fair (i.e., that the probability of 'heads' is 1/2). Prior to performing the experiment, the investigator has some reason to believe that 'heads' is more likely than 'tails' and therefore wants to do a one-sided hypothesis test. In 10,000 tosses of the coin, 'heads' came up 5134 times. The p-value for this outcome is .004. Which conclusion is most appropriate?

**a.** The null hypothesis is true.
**b.** Fail to reject the null hypothesis.
**c.** Reject the null hypothesis at the 10% level of significance, but not at the 1% level of significance.
**d.** Reject the null hypothesis at the 1% level of significance.

**16.** (10 points) A sport fitness researcher compares two training programs designed to prepare participants for a cross-country race. The researcher selects 30 volunteers, of varying fitness levels. Each participant is assigned to a fitness level of "low" or "high", using the participant's present fitness level as a criterion. Within each fitness level, participants are randomly assigned to the two training programs, by flipping a coin for each person. When the flip is "heads," program 1 is used. When the flip is "tails," program 2 is used. What type of study is this?

**a.** An observational study.
**b.** A randomized block design.
**c.** A completely randomized experiment.
**d.** A double blind study.

**17.** (10 points) In testing the mean of a single sample, the z-test should be used rather than the t-test if:

**a.** The population standard deviation is known.
**b.** The sample standard deviation is known.
**c.** The sample size is less than 20.
**d.** All of the above.

**18.** (10 points) In the articles by Cryer, Knuesel, McCullough, and McCullough & Wilson, many different problems with Microsoft Excel for Statistics have been reported.

Which of the following has not been reported as a problem for Excel in these articles?

**a.** Excel can compute negative variances.
**b.** The Excel random number generator fails randomness tests.
**c.** The Excel treatment of missing data is done incorrectly and inconsistently.
**d.** Excel can produce incorrect square root, exp, and log results.

**19.** (10 points) Why should we use residual plots? What can residual plots detect?

**a.** Residual plots aid in evaluating the validity of the model and can suggest ways in which to improve it.
**b.** Residual plots help detect curvature, outliers, and points with high leverage.
**c.** Residual plots help detect differences in the standard deviation of the residuals, and lack of normality in the residuals.
**d.** All of the above.

**20.** (10 points) Suppose you were given a 95% confidence interval for the difference in two population means. What could you conclude about the two population means if the confidence interval contained both negative and positive numbers?

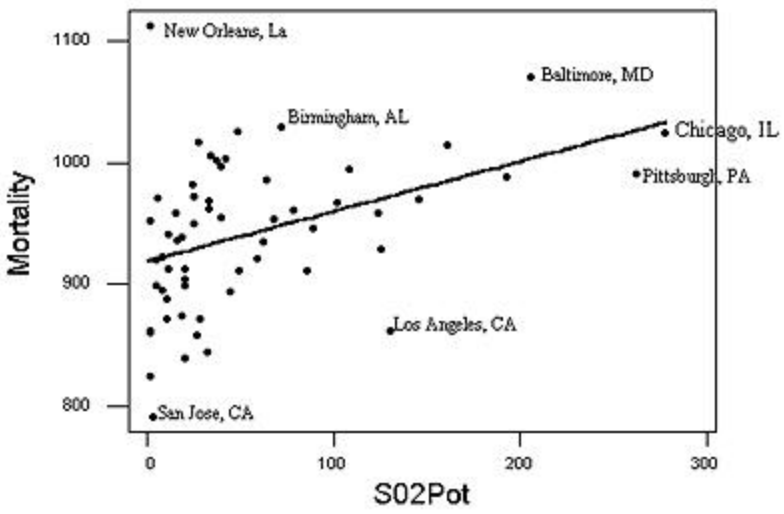
**a.** The first mean is larger than the second mean.
**b.** The first mean is smaller than the second mean.
**c.** The means differ, but it is not clear which is larger.
**d.** The means do not differ.

**21.** (14 points) What is the general formula for a confidence interval for a mean (using any confidence level alpha)?

**22.** (14 points) The scatter plot is based on data from the 50 states, plus Washington, D.C.: Y (Mortality) is age-adjusted mortality and X (SO2Pot) is sulfur dioxide potential.

(i) Which of the labeled locations has the highest age-adjusted mortality score?

(ii) Which of the labeled locations has the residual closest to zero?



**23.** (14 points) Data for the 50 states plus Washington, D. C. includes the following three variables:

- Income: median household income in thousands of dollars;
- TeacherSalary: the average salary of primary and secondary school teachers, in thousands of dollars; and
- Poverty: the percentage of people in poverty.

The table below contains least squares estimates for some linear models:

| Model | Estimates |
|---|---|
| $Income = a + b \times TeacherSalary + E$ | a: 14.05, b: +0.5227 |
| $Income = a + b \times Poverty + E$ | a: 42.78, b: -0.7380 |
| $Income = a + b \times TeacherSalary + c \times Poverty + E$ | a: 25.84, b: +0.4214, c: -0.6218 |

(i) If teacher salaries are held fixed, an increase of one percentage point in the poverty rate is associated with what change in the median household income (in thousands of dollars)?

(ii) What is the expected change in median household income associated with an increase of one percentage point in the poverty rate?

**24.** (14 points) Researchers are interested in testing whether there are an excessive number of rat hairs in jars of peanut butter produced at a particular factory. They examine a random sample of 144 jars, and find an average of 6.3 rat hairs in each jar. The sample standard deviation is 2. They would like to do a one-sided z-test of whether the population average is equal to five (the maximum permitted by law) versus the alternative that it is greater than five.

What is the z-statistic?

**25.** (14 points) Do male and female college-aged students differ with respect to the number of times they brush their teeth each day? A sample of 59 males and 80 females were asked: 'How many times do you brush your teeth each day?'

The resulting data are summarized in the following table:

| Gender | # brush teeth more than once a day | total # surveyed |
|---|---|---|
| Males | 52 | 70 |
| Females | 46 | 59 |

Calculate a 95% confidence interval for the proportion of females who brush their teeth more than once a day.

**26.** (14 points) Suppose that research is done to compare two methods for improving fitness. The available participants range in age from 18 to 54 years old. The investigator knows that participant age will affect the response to these methods. A randomized block design in which age blocks are formed might be accomplished by dividing the participants into age groups, for example, age 18-24, age 25-34, and age 35-54.

| Participants and Ages | | |
|---|---|---|
| Murphy, 18 | Becker, 39 | Vandine, 47 |
| Sprechini, 29 | Perry, 18 | Yin, 36 |
| James, 30 | Jones, 20 | Davis, 34 |
| Mitchell, 54 | Krall, 22 | Doetzel, 42 |
| Torres, 25 | Manzitti, 24 | |

If participants are arranged into three blocks using mathematical aptitude as the blocking criterion, who would be in Block 1: Age 18-24?

**27.** (14 points) The annual amount spent on reading (in dollars) for a random sample of college students was obtained by means of a survey. These students are located in four geographic areas of the United States: Northeast, Midwest, South and West.

The following ANOVA table was produced:

| Analysis of Variance Results | | | | | |
|---|---|---|---|---|---|
| **Source** | **df** | **SS** | **MS** | **F-ratio** | **P** |
| **Factor (Region)** | 3 | 32832 | 10944 | 2.63 | 0.075 |
| **Error** | 23 | 95857 | 4168 | | |
| **Total** | 26 | 128689 | | | |

(i) Indicate how the Error df is calculated.
(ii) Indicate how the F-ratio is calculated.

**28.** (14 points) Bags of a certain brand of tortilla chips claim to have a net weight of 14 ounces. Net weights actually vary slightly from bag to bag and are normally distributed with mean $m$. A representative of a consumer advocate group wishes to see if there is any evidence that the mean net weight is less than advertised and so intends to test the hypotheses $H_0: m = 14$ and $H_a: m <> 14$. To do this, he selects 16 bags of this brand at random and determines the net weight of each. He finds the sample mean $\bar{x}$ to be 13.88 and the sample standard deviation s to be 0.24.

(i) Indicate the t-statistic for testing the null hypothesis,
(ii) indicate the degrees of freedom, and
(iii) determine the approximate p-value.

**29.** (14 points) Samples of three brands of batteries commonly used in cell phones were tested for length of life. A researcher is interested in comparing the mean length of life of these three brands. She randomly selected six samples of each brand and generated the following WebStat output:

```
Analysis of variance results:

Source       df     SS        MS        Fstat    Pval
Treatments    2    91.44     45.72      5.637    0.0149
Error        15   121.7       8.111
Total        17   213.14
```

We have to use an F-distribution with (i) ___ and (ii) ___ degrees of freedom as test statistic for the significance test used here. Note that the order matters in which you fill in the numbers.

**30.** (14 points) Do study breaks affect exam scores? The exam scores for a sample of 28 students who had one 15 minute break and 34 students who had three 15 minute breaks during a 2 hour study period have been obtained. Here, the sample data will be used to determine whether students who had one 15 minute break had lower exam scores than students who had three 15 minute breaks during a 2 hour study period. The following Minitab output pertains to the analysis:

```
Two-sample T for Exam
 Breaks      N    Mean    StDev  SE Mean
OneBreak    28   71.07    1.52     0.29
ThreeBreak  34   71.65    1.05     0.18
 Difference = mu (OneBreak ) - mu (ThreeBreak)
Estimate for difference:  -0.587
95% CI for difference: (-1.242, 0.068)
T-Test of difference = 0 (vs not =): T-Value = -1.79  P-Value = 0.078  DF = 60
Both use Pooled StDev = 1.28
```

Indicate the formula and the numerical result how we calculate the degrees of freedom for the pooled t-statistic here.

**31.** (14 points) There is some evidence that the natural body temperature for humans is actually below the 98.6 degrees Fahrenheit everyone is familiar with. (From 'Datasets and Stories' article 'What's Normal? -- Temperature, Gender, and Heart Rate' (1996) by

Shoemaker in the Journal of Statistics Education.) To test this idea, investigators took a simple random sample of 130 adults from a large population, and recorded the body temperature of each of the 130. The sample mean of the body temperatures of the 65 males was 98.105 degrees, and the sample standard deviation of the measurements was 0.699. We want to test whether the mean body temperature of male adults from that city is 98.6 degrees.

(i) Calculate the z-statistic for testing the null hypothesis.
(ii) Determine the approximate p-value.

**32.** (14 points) Assume that 35% of the adults in the United States would be willing to support campaign financing reform. The people willing to support campaign financing reform have value '1', and those unwilling have value '0.' Thus the population mean is 0.35. The population standard deviation is 0.477.

Determine the probability that the sample mean of 700 observations will be between 0.30 and 0.36.

**33.** (14 points) What role does the size of an expected count play in determining whether two-way table methods can be used? We know that these methods should not be used if any expected count is less than 1.

A second rule states that the methods should not be used if more than (i) _____% of the expected counts are less than (ii) _____.

**34.** (14 points) Think of a bag of marbles, where the bag weighs about 2 ounces, and each marble weighs about 1.5 ounces. The total weight Y in ounces is related to the number of marbles X by the linear equation

$$Y = 2 + 1.5 \times X$$

(i) What is the slope in this equation?
(ii) What is the total weight if there are 6 marbles?

**35.** (14 points) For 6 patients, the least squares line for X = Dosage of a medication versus Y = Decrease in pulse rate is

$$Decrease = 2.8 + 5.3 \times (Dosage).$$

The correlation coefficient is 0.96, the sum of squared deviations of the Dosages is 3.83, the sum of squared deviations of the Decreases is 114.8, the sample standard deviation of the residuals is 1.48 and the standard error of the slope is 0.76.

(i) What is the value of the t-statistic for testing the null hypothesis that the slope b = 0?
(ii) What are the degrees of freedom needed for the calculation of the p-value?
(iii) What is the approximate p-value associated with this t-statistic?

For a class project, one student decided to compare the sales at a toy store for different shelf heights where the toys are stored. Since she works at that store, she was able to obtain permission to randomly change the shelf height at which the toy was displayed each day. She used Height1 = 16 inches (40.64 cm) above ground, Height2 = 32 inches (81.28 cm) above ground, and Height3 = 48 inches (121.92 cm) above ground. The following table gives the sales, in dollars, of the toy per day for each shelf height:

| Shelf Height | | |
|---|---|---|
| Height1 | Height2 | Height3 |
| 380 | 356 | 350 |
| 375 | 360 | 350 |
| 365 | 355 | 353 |
| 374 | 340 | 362 |
| 367 | 378 | 340 |

Enter the data into 3 columns in WebStat. Please check carefully that you enter the correct values or I may not be able to verify your results!

The next 5 questions will work with this data set. One goal of these questions is that you demonstrate that you can use a statistical software package such as WebStat. So, please report your answers exactly as obtained from WebStat. If WebStat indicates a mean of 391.7935, please indicate this value on your answer sheet and do not round to 392.

**36.** (18 points) Calculate and report (i) the mean for Height1, (ii) the median for Height2, and (iii) the range for Height3.

**37.** (18 points) Conduct a one-way ANOVA on Height1, Height2, and Height3. State the null and alternative hypotheses that relate to this ANOVA.

**38.** (18 points) Report the p-value of the one-way ANOVA from question 37 and conclude whether we reject (or do not reject) the null hypothesis and draw a conclusion.

**39.** (18 points) Can we conclude that the population mean sales for toys stored at Height1 is higher than that for toys stored at Height2? Conduct a one-sided two-sample t-test with pooled variances to answer this question. Report the p-value and conclude whether we reject (or do not reject) the null hypothesis and draw a conclusion.

**40.** (18 points) Can we conclude that the population mean sales for toys stored at Height2 is higher than that for toys stored at Height3? Conduct a one-sided two-sample t-test with pooled variances to answer this question. Report the p-value and conclude whether we reject (or do not reject) the null hypothesis and draw a conclusion.