Stat 1040, Spring 2008 **Name:** ____________________

Final Test, May 1, 1:30pm–3:20pm

Show your work. The test is out of 100 points and you have 110 minutes to finish.

1. **Does Aspartame Cause Cancer?** Aspartame is an artificial sweetener found in thousands of products – sodas, chewing gum, dairy products and even many medicines. Some research has suggested that aspartame can cause lymphoma or leukemia in rats.

   A recent study by the National Cancer Institute involved 340,045 men and 226,945 women, ages 50 to 69. From surveys they filled out in 1995 and 1996 detailing food and beverage consumption, researchers calculated how much aspartame they consumed. Over the next five years, 2,106 developed cancers such as lymphoma or leukemia. No association was found between aspartame consumption and occurrence of these cancers.

   (a) (2 points) Was the study a controlled experiment or an observational study? Why? ✓

   It was an observational study because the subjects decided how much aspartame to consume.

   not the researchers

   (b) (4 points) Suggest a possible confounding factor for this study and explain why your confounding factor might make you doubt their results.

   A confounding factor might be that the ones who consumed aspartame might have been trying to control their weight and might look after themselves better in other ways (exercise, eating right, etc). Perhaps these other things are compensating for an increased cancer risk from aspartame.

   (c) (2 points) "It's very reassuring. It's a large study with a lot of power," said Richard Adamson, a senior science consultant to the American Beverage Association, the leading industry group. Does the large sample size prove that aspartame does not cause cancers such as lymphoma or leukemia? Explain.

   No, because it was not a well-designed study. Even if it had been a randomized, controlled, double-blind study, we would still have doubts because we never really "accept" the null.

   believe

2. A randomized, controlled, double-blind study published in March, 2008 shows the well-known "placebo effect" works even better if the placebo costs more. In the study, volunteers were given an electric shock and took a pill. Volunteers in the treatment group were told it was an expensive painkiller, while those in the control group were told it was a discounted painkiller. In fact, all the pills were placebos, but 85% of the volunteers who thought they were getting an expensive painkiller said they felt less pain after taking it, compared to 61% of those who thought they were getting a discounted painkiller.

   (a) (1 point) What is a placebo?

   A placebo is something that resembles the treatment but lacks the active ingredient.

   (b) (3 points) Why is a placebo used in a controlled experiment?

   A placebo is used so that the experiment will be blind, i.e. people won't know which group they are in. This is done so that anything we see is due to the treatment, not the idea of treatment

   (c) (2 points) What sort of a test would you use if you wanted to test whether the difference between the two percentages could be due to chance error? (Circle the correct answer)

   - one-sample z-test
   - one-sample t-test
   - two-sample z-test
   - Chi-square test

3. (4 points) In a flyer by Horizon Textbook Publishing, a customized textbook manufacturer, they cite Dr. Blount, Gaston College, as follows:

   > "After 4 years with my Horizon customized textbook, I've witnessed an increase in both grade point averages and instructor evaluation scores. Thanks, Horizon!"

   Assuming that his grade point averages and instructor evaluation scores really did increase, can we attribute the increase to the Horizon customized textbook? **Yes** / **No**? Circle your answer and explain, using the appropriate statistical terms. Provide two *different* reasons to justify your answer.

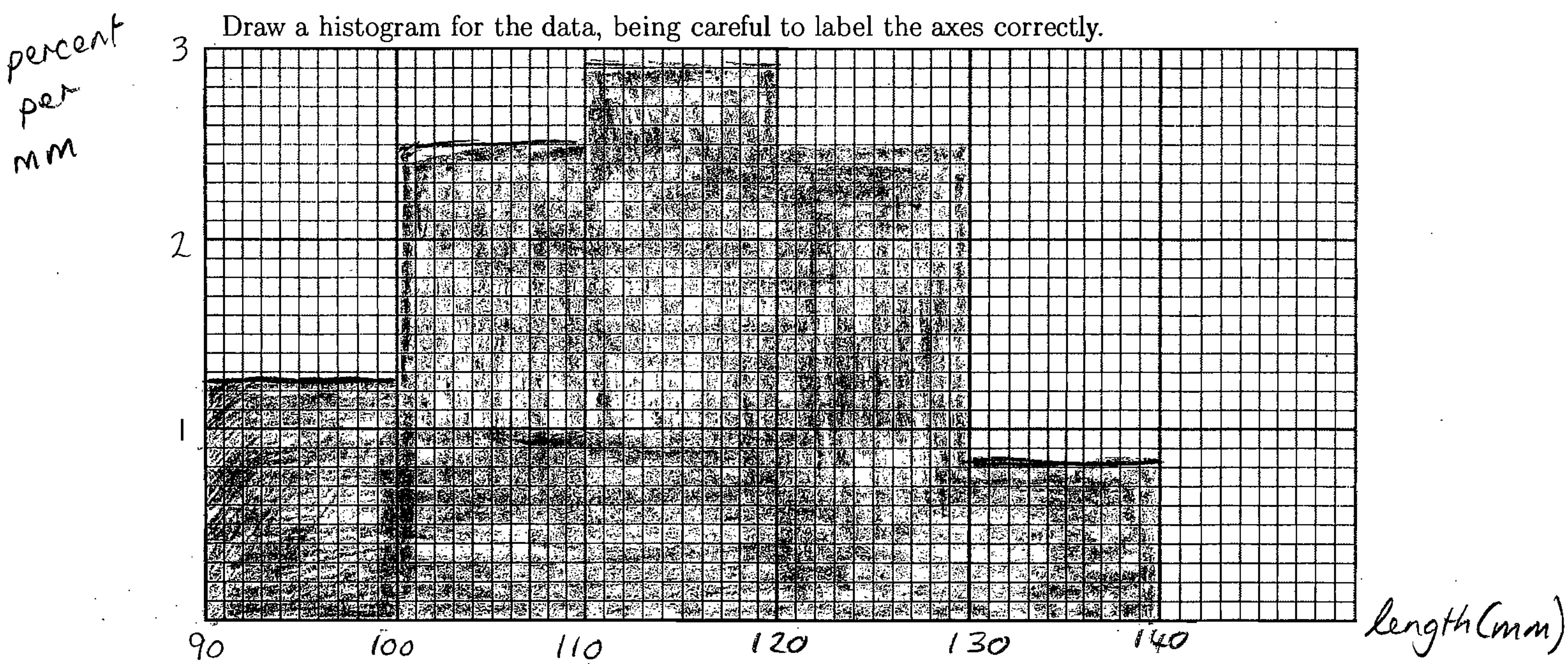
   Association is not causation: there could be many other reasons why scores increased in that 4-year period,
   e.g. - he gained experience & taught better
   - university changed entry standards
   - different majors started taking his class
   - grade inflation

   etc. etc.

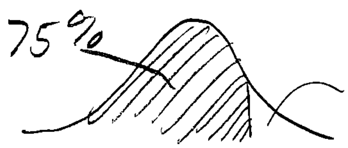
4. (8 points) The following table summarizes the lengths of 24 male painted turtles. Class intervals include the left endpoint but not the right.

Length (mm)	Number of turtles	Percentage of turtles	width	height
90 to 100	3	$\frac{3}{24} \times 100\% = 12.5\%$	10	$12.5/10 = 1.25$
100 to 110	6	25.0%	10	2.50
110 to 120	7	29.2%	10	2.92
120 to 130	6	25.0%	10	2.50
130 to 140	2	8.3%	10	.83
	24	100%		

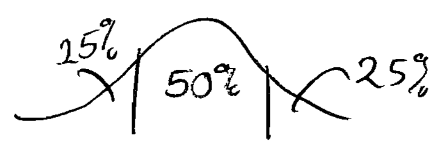
Draw a histogram for the data, being careful to label the axes correctly.



5. (7 points) The length of female painted turtles follows the normal curve with an average of 136 mm and an SD of 21 mm. If the length of one of these turtles is at the 75th percentile, what is her length?



100% − 75% = 25%



so from the table, $z = .65$ or $.7$

and length $= (.65)(21) + 136$

$= 150$ mm.

6. The length and width of 24 male painted turtles have the following summary statistics:

Length:	average = 113 mm	SD = 12 mm	r = 0.95
Width:	average = 88 mm	SD = 7 mm	

The scatter-diagram is football-shaped.

alternative method: slope $= .95\left(\frac{7}{12}\right) = .554$
int $= 88 - .554(113)$
$= 25.4$
width $= .554$ length $+ 25.4$
$= .554(130) + 25.4$
$= 97.4$ close enough!

(a) (5 points) Predict the width of a turtle that is 130 mm in length.

130 mm is 17 mm above average

That's $\frac{17}{12} = 1.4$ SDs above average.

We predict it will be r times 1.4 SDs above ave in width.
$(.95)(1.4) = 1.3$

So width $= (1.3)(7) + 88 = 97$ mm

(b) (1 point) What is the rms error for your prediction in part b)?

$\sqrt{1-r^2}\,(SD_y) = \left(\sqrt{1-.95^2}\right)(7) = 2.2$

7. A class of ~~25~~ 26 fourth-graders has 14 boys and 12 girls. This class goes on a field trip. Two children are chosen at random to ride with the teacher.

(a) (1 point) What is the chance the first child is a boy?

$\frac{14}{26} = .54$

(b) (2 points) What is the chance the second child is a boy?

$\frac{14}{26} = .54$

(c) (2 points) What is the chance both children are boys?

BB $\frac{14}{26} \times \frac{13}{25} = .28$

(d) (2 points) What is the chance neither of the children are boys?

GG $\frac{12}{26} \times \frac{11}{25} = .20$

(e) (2 points) What is the chance one of the children is a boy and the other is a girl?

BG or GB

$\underbrace{\left(\frac{14}{26} \times \frac{12}{25}\right)}_{.26} + \underbrace{\left(\frac{12}{26} \times \frac{14}{25}\right)}_{.26} = .52$

8. **German Internet Study** This question relates to a study published in April 2008 at `http://www.sevenoneinteractive.de/`. This was a telephone survey in which 1,009 Germans were asked questions about how they used the internet at home.

(a) (12 points) One of the questions asked people how many Web sites they frequently revisited. For the 505 men in the study, the average was 9.4 with an SD of 8.3. For the 504 women in the study, the average was 6.4 with an SD of 6.0. Is this evidence that the average for all German men is higher than the average for all German women, or could the result just be due to chance error? (Assume these are two independent simple random samples from all German men and women.)

i. Clearly state the null and alternative hypotheses.

null: the average for all German men is the same as the average for all German women.

2

alt: the average for all German men is higher than the average for all German women.

ii. Calculate the appropriate test statistic.

men: 505, $ave_{box} = ?$, $SD_{box} = ? \approx 8.3$

women: 504, $ave_{box} = ?$, $SD_{box} = ? \approx 6.0$

$SE_{sum} = \sqrt{505}\,(8.3) = 186.5$ $\quad$ $SE_{sum} = \sqrt{504}\,(6.0) = 134.7$

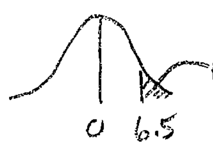
$SE_{ave} = \frac{186.5}{505} = .37$ $\quad$ $SE_{ave} = \frac{134.7}{504} = .27$

4

$$SE_{\underset{ave}{diff}} = \sqrt{.37^2 + .27^2} = .46$$

$$z = \frac{9.4 - 6.4}{.46} = 6.5$$

iii. Find the P–value.



P-value is tiny (off the chart)

iv. Do you reject the null hypothesis? Explain why or why not.

2

We reject the null hypothesis because the P-value is less than 5%.

v. State your conclusions.

2

We conclude that the average for all German men is higher than the average for all German women.

(b) (10 points) According to an earlier study, German men visit an average of 20 new Web sites in a typical month. For the 505 men in the new study, the average number of new Web sites visited in a typical month was 20.8 with an SD of 21.6. Does the new study justify the following newspaper headline: "New study shows that German men visit an average of **more than 20** new Web sites in a typical month."? (Assume this is a simple random sample from all German men.)

i. Clearly state the null and alternative hypotheses.

2

null: German men visit an average of 20 new websites in a typical month.

alt: German men visit an average of more than 20 new websites in a typical month.

ii. Calculate the appropriate test statistic.

ave box = 20 (<u>not</u> 20.8!!)

SD_{box} = ? ≈ 21.6 (bootstrap)

$SE_{sum} = \sqrt{505}\,(21.6) = 485.4$

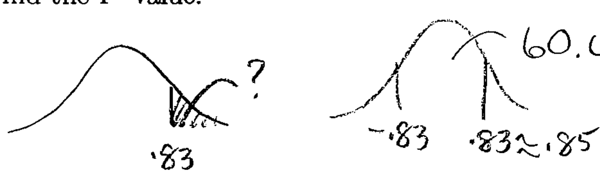
4

$SE_{ave} = \frac{485.4}{505} = .96$

$Z = \frac{20.8-20}{.96} = .83$

iii. Find the P–value.

2



100% - 60% = 40% both tails

$\frac{40\%}{2} = 20\%$ in each tail

P-value = 20%

iv. Do you reject the null hypothesis? Explain why or why not.

1

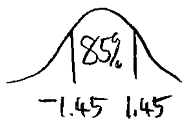
We fail to reject the null because the P-value is larger than 5%.

v. State your conclusions.

1

There is insufficient evidence to conclude that German men visit an average of more than 20 new websites in a typical month. i.e. the newspaper headline is <u>not</u> justified.

(c) (8 points) Among the 350 people in this study aged 20 to 29 years, 12.6% visit more than 50 new Web sites in a typical month. Find an 85% confidence interval for the percentage of all Germans aged 20 to 29 years who visit more than 50 new Web sites in a typical month. (Assume this is a simple random sample of all Germans aged 20 to 29 years.)



Sample % $\pm$ 1.45 $SE_{\%}$

$12.6\% \pm (1.45)(1.76\%)$

$12.6\% \pm 2.6\%$

box is approximately

44 $\boxed{1}$ 306 $\boxed{0}$ $SD_{box} \approx .33$

$SE_{sum} = \sqrt{350}\,(.33) = 6.17$

$SE_{\%} = \frac{6.17}{350} \times 100\% = 1.76\%$

(d) (2 points) Suppose we found out that the samples really came from an online questionnaire exclusively available to people who visited the German version of "myspace" (myspace.de). Which, if any, of the results from the previous three questions are still valid? Explain.

None of them are valid because our methods only work for simple random samples. This would be a sample of convenience and no statistically valid conclusions can be drawn from a sample of convenience.

9. (8 points) For Utah men aged 50–80, the average number of hours of hard physical activity a week is 14 hours, with an SD of 15 hours. I plan to take a simple random sample of 225 Utah men aged 50-80. What is the chance that the average number of hours of hard physical activity a week for the men in the sample lies between 12.5 and 15.5?

The average of 225 draws from the box

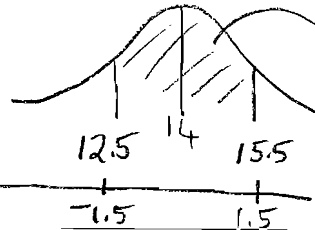
$\text{ave}_{box} = 14$

$SD_{box} = 15$

$EV_{ave} = 14$

$SE_{sum} = \sqrt{225}\,(15) = 225$

$SE_{ave} = \frac{225}{225} = 1$



area = 86.64%

accurate expected counts

201	266	92
244	322	111

expected counts

200	265	91
245	323	112
445	588	203

10. (12 points) In one analysis of the data from the Utah Study of Nutrition and Bone Health they looked at the relationship between BSM1 vitamin D receptor genotype and whether or not a person has a hip fracture. The data for the women in the study are summarized in the table below. Assume this is a simple random sample from the population.

		Genotype			
		+/+	+/-	-/-	
Hip Fracture?	**Yes**	183	281	95	559
	No	262	307	108	677
		445	588	203	1236

$\frac{559}{1236} \times 100\% = 45\%$

45% of 445 is $\frac{45}{100} \times 445 = 200$

45% of 588 is $\frac{45}{100} \times 588 = 265$

45% of 203 is $\frac{45}{100} \times 203 = 91$

We are interested in whether or not genotype and hip fracture are independent in this population.

(a) Clearly state the null and alternative hypotheses.

null: hip fracture is independent of genotype

alt: " " is not " " "

(b) Calculate the appropriate test statistic.

obs	exp	$(o-e)^2/e$
183	200	1.45
262	245	1.18
281	265	.97
307	323	.79
95	91	.18
108	112	.14

$\chi^2 = 4.71$

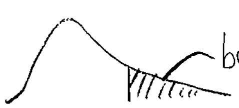
$df = (2-1)(3-1) = 2$

more accurate:

		$(o-e)^2/e$
183	201	1.61
262	244	1.33
281	266	.85
307	322	.70
95	92	.10
108	111	.08

$\chi^2 = 4.67$

(c) Find the P–value.



4.71

between 5% and 10%

(d) Do you reject the null hypothesis? Explain why or why not.

We fail to reject the null because the P-value is greater than 5%.

(e) State your conclusions. There is no evidence hip fracture & genotype are not independent.