STATISTICS 220 **WINTER 2006** **MIDTERM EXAM**

Friday February 17, 2006; 8.30 a.m. - 9.20 a.m.

NAME _____ SECTION: (circle 1); AA AB AC AD AE AF

1.This is a closed-book, closed-notes exam, except that each student
may refer to one (two-sided) $8\frac{1}{2}$ by 11 page of notes (s)he has brought to the exam.
2.Use of a calculator is allowed.
However, in order to receive full credit, all computations must be shown.
3.Students must clearly explain each answer to receive full credit.
4.Students must follow a reasonable code of conduct.

Cheating or other dishonest practices will result in an examination grade of zero. Such practices include, but are not limited to (i) making use of books, papers, or memoranda other than those authorized, (ii) speaking or communicating with other students during the examination, (iii) purposely exposing written papers to the view of other students.

5.If you do not sign the Honor statement below, then your exam score will be zero.

A good strategy: Skim the entire exam.
Then work first the problems with which you feel most comfortable.
Answer as many of the questions as you have time for.
This is a long exam for 50 minutes; don't worry if you cannot complete it all.

Honor statement:
I have followed a reasonable code of conduct in conjunction with this exam, as outlined in point 4 above.

_____
Student signature

Please do not write in this space.

Question number	points	possible points
1		12
2		12
3		12
4 (a)		8
(b)		4
Total		48

1. (12 points: 4 each part) **Explain your answers**:
The following news headlines were prompted by the facts given below them. (Some are hypothetical, some based on actual recent reports.) For each comment on whether the headline is supported by the facts, and why or why not.

(a) **Headline:** Commuting more dangerous than walking on the freeway.
Facts: Between 1980 and 2000, 39 people were killed in automobile accidents on the I-5 freeway between Tacoma and Everett during commuting hours. During the same years and hours, 4 people walking on the same stretch of the I-5 freeway were killed by being hit by vehicles.

No, this one makes no sense. Probably a million people commute on some part of this freeway every work day, almost all in safety. The 39 out of all these millions and millions (over 20 years), is a much, much smaller proportion than the 4 out of the very few people walking on the freeway, whether as workers, or because they abandonned their cars, or whatever reason. Risk/danger is relative to the numbers of people involved.

(b) **Headline:** Study shows watching TV causes school violence.
Facts: In a large-scale study, across several urban school-districts, of boys aged 7 to 10 years old, there was a strong positive association between the number of hours per day watching TV, and a professionally measured tendency to react with physical violence in conflict situations with their classmates.

No, association is not cause. There could be many confounding factors here, probably relating to the home environment – socio-economic status, family structure, parents' education, etc. etc. – at least one specific suggestion required for full credit. Note a confounding factor must affect both TV watching and "violence".

(c) **Headline:** New drug shows promise for treating gambling addiction.
Facts: In a study funded by the drug manufacturers, a new drug was tested on a total of 200 patients (about 50% men and 50% women) over 15 centers across the US. After 3 months on the treatment, 60% of the patients reported a "significant decrease" in their gambling compulsion.

Well it might be worth conducting further studies of this drug, but in this study as yet there are no controls, the subjects were self-selected – treatment is not assigned by investigator. The study is not blinded, and the benefits are self-reported. (Also, what did the other 40% say?) There is high potential here for a placebo effect.

2. (12 points; 3 each part) **Show your work: justify your answers**
In designing a new fighter plane, the U.S. Air Force initially requests a design for the pilot's seat so that it "accommodates comfortably" a pilot who is no more than 74 inches tall, and who is no more than 23 inches across the shoulders.

In a study of persons applying for training to fly the new planes it is found that the mean height is 68 inches with an SD of 4 inches, and that the mean shoulder breadth is 21.25 inches with an SD of 1.0 inch. Both histograms are approximately of normal shape.

(i) What percentage of trainee pilots are too tall to fit comfortably into the seats?

z-score for height limit = (74-68)/4 = 1.5
From table, between-area for z=1.5 is 87%
So (100-87)/2 = 6.5% would be too tall.

(ii) If the Air Force wants to have no more than 4% of trainee pilots being too tall to fit comfortably into the seats, what "maximum comfortable height" specification should they give to their seat designers?

For 4% too tall, we need between-area = (100 -2 $\times$ 4) = 92%
From table, this corresponds to z-score = 1.75
So the specification needs to be 68 + 1.75 $\times$ 4 = 75 inches.

(iii) Does the Air Force have to change its shoulder-breadth specification in order for no more than 4% of trainee pilots to be too broad across the shoulders to fit comfortably into the seats?

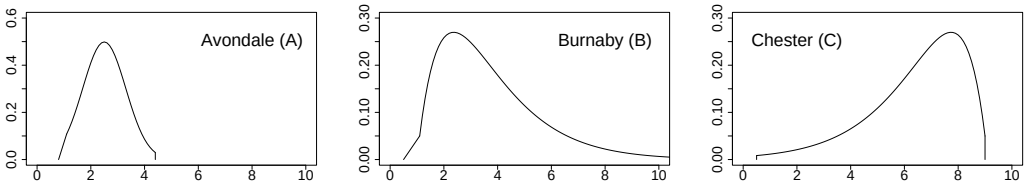
With the current specification, z-score = (23 - 21.25)/1 = 1.75
From the table, the between-area is 92%
So 4% are too broad with current specification.
So no change is required.

(iv) The seat designer says; "If 4% of the trainee pilots are too tall, and 4% are too broad, to fit the seats comfortably, that means a total of 8% of trainee pilots will not fit the seats comfortably." Do you agree? Why/why not?

No, it will be somewhere between 4% and 8%, but some of the ones who are too tall, are very likely some of those who are too broad.

3: (12 points: 4 each part) **Explain your answers: EXCEPT (a)**
(Note question 3(c) is on the next page of this exam.)

(a) The three histograms shown house prices in units of $100,000 in three suburbs Avondale (A), Burnaby (B), and Chester (C) of a large US city.



Without explanation, identify the suburb

(i) with the smallest proportion of houses priced under $250,000 **Chester**

(ii) with the largest range of house prices **Burnaby**

(iii) with the smallest mean house price **Avondale**

(iv) where the median house price is smaller than the mean **Burnaby**

(b) All international graduate students are required to take a SPEAK test in spoken English before being allowed to be a teaching assistant (TA). Typically, on each offering, 80% of the students pass the test. This pass rate is very little affected by whether students have taken the test previously.

In an effort to help students qualify as TAs, the University implements a plan to give extra tutoring to the students who fail the test. At the next offering, 95% of the students who received tutoring pass the test.

The University conducts a study, and finds that among the students in their extra-tutoring program, there is no correlation between the number of hours of extra tutoring and the score of the students on their next SPEAK test. The University is disappointed and proposes to cancel the program, since the tutoring apparently has "no effect".

Do you agree? How would you advise the University?

No, the fact that 95% of the students passed the test suggests that the extra tutoring is having some substantial effect, although we do not know how these students would have done without the program – there are no controls.

There could be many reasons why we do not see a correlation. It could be that the range of either the tutoring hours or of the resulting performance is too small. Or it could be that it is not the number of hours of tutoring that is the important positive aspect of the program.

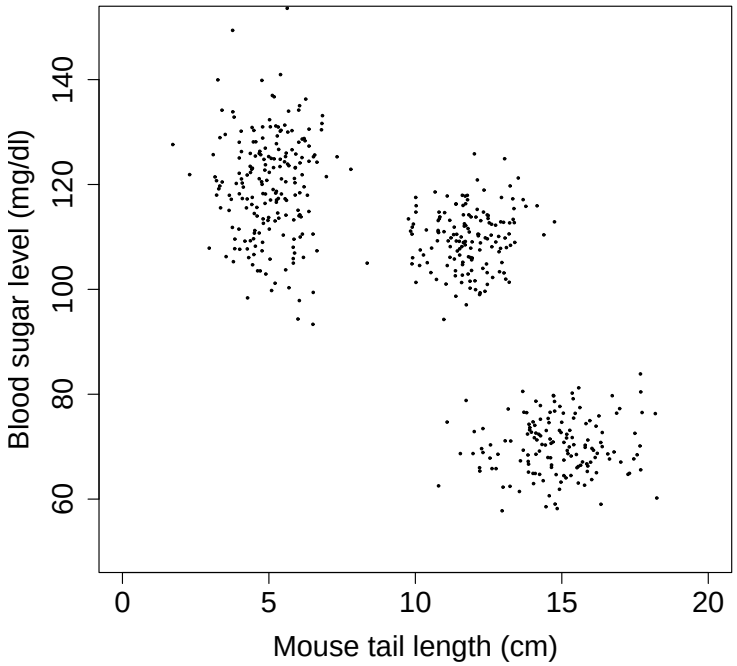
Probably the University should do a more careful study of the program benefits.

(2 points for seeing there is effect; two points for why maybe no correlation observed).

Continuation of Question 3

(c) Your friend is conducting a study of the association between tail length and blood sugar level in mice. She measures a lot of mice, of 3 different kinds, and reports to you that there is a strong negative correlation. She wants to report on this new finding at a big conference.

You insist on seeing the scatterplot, and it is as shown. How would you advise your friend?



What we have here are <u>three distinct groups</u>, probably corresponding to the 3 kinds of mice the friend used in her study. Within each group there is <u>no association</u> at all between tail-length and blood-sugar-level. One group has short tails, high blood-sugar, and high spread (SD) of blood-sugar. Another group has long tails (with high SD) and low blood-sugar. The third group is intermediate in both variables (with small SD for each). It is this pattern of the groups that is giving the <u>apparent negative correlation</u>. The mouse-type is a confounding factor.

For these three particular kinds of mice, knowing which kind it is might help predict both tail length and blood-sugar level, but there is no reason to expect this negative relationship will extend to mice in general— we have a sample size of 3 – that is, the three kinds.

(2 points for seeing that the negative association comes from a mixture of 3 populations: 2 for pointing out that within group there is no association)

4 (12 points: 8 points (a), 4 points (b); 2 for each bit)

In a study of human growth, 850 Minnesota boys born in 1980 were measured at age 6 and at age 18. The results were as follows:
At age 6 (in 1986); mean height = 46 inches, SD = 2.0 inches
At age 18 (in 1998); mean height = 70 inches, SD = 2.5 inches,
correlation (r) = 0.8. The scatter plot was football shaped.

(a)**Show your work**
(i) What percentage of boys aged 18 had heights over 75 inches ?

z-score = (75-70)/2.5 = 2
From table, between-area = 95%
So half the remaining 5% will be taller; that is 2.5%

(ii) For boys who at age 6 were just about 50 inches tall, what is their average height at age 18?

At age 6, these boys are (50-46)/2 = 2 SD above the mean.
Prediction is that at age 18 they will be
(mean + r $\times$ 2 $\times$ (SD of y) = 70 + 0.8 $\times$ 2 $\times$ 2.5 = 74 inches

(iii) For boys who at age 6 were just about 50 inches tall, what is the SD of their height at age 18?

This SD is the rms error = $\sqrt{1-r^2}\times$ **(SD of y)**
This works out to $\sqrt{0.36}\times\ 2.5\ =\ 0.6\times 2.5\ =\ 1.5$ **inches.**

(iv) For boys who at age 6 were just about 50 inches tall, what percentage were over 75 inches at age 18.

The z-score for this is (75-74)/1.5 = 0.67
From table, the between-area is 50%
So the percentage of these tall 6-year-olds who will be over 75 inches is 25%

(b) Your Minnesota friend has a son age 6. She reads about the study and says to you "Ours is a typical Minnesota family: now I can make a good prediction of how tall my son will be when he's 18".

(i) Give one sentence explaining why (statistically) this is a reasonable statement.

The regression prediction will give her the average height at 18, for kids of her son's current age-six height. Because of the strong correlation this gives a reasonably accurate prediction, insofar as the study summarizes the typical growth patterns of boys from 6 to 18, in a fairly homogeneous population.

(ii) Give one sentence explaining why (statistically) your friend should perhaps be cautious about this prediction.

A case of do not extrapololate; things change, even over only 20 years. Maybe there have been recent changes in early childhood nutrition practices, or there will be changes in teenage lifestyles over the future 12 years, that will change the relationship between heights at 6 and at 18, for current 6-year-olds.
(Prediction error/variation comment gets one point)

A SHORT TABLE OF THE NORMAL DISTRIBUTION

z	Area (percent)
0.0	0
0.1	8
0.2	16
0.25	20
0.50	38
0.58	44
0.67	50
0.75	55
1.00	68
1.25	79
1.50	87
1.65	90
1.75	92
2.00	95
2.25	98
3.00	99.7

HERE WILL BE A PICTURE OF THE NORMAL CURVE WITH SHADED MIDDLE AREA, JUST AS IN FPP ON PAGE A-105.