

Name: _____ Section: (day/time) _____

AMS5 - MIDTERM
Thursday 5th February, 2009

A Normal Table is on the last page of this exam.

1. A professor has five different colored sweaters in his closet. During the day, his small children play in the closet, and enjoy rearranging the sweaters in a random order. Each morning, the professor picks the sweater off the top of the pile, and wears it to class.

The professor's students have noticed, however, that in 10 class sessions, the professor has always worn the same sweater.

- (a) What is the chance of this occurring?

$$\left(\frac{1}{5}\right)^{10} \approx 1 \times 10^{-7}$$

- (b) What is the chance that during the next 6 class sessions, the students will see this sweater exactly 4 times?

$$\frac{6!}{4!(6-4)!} \cdot \left(\frac{1}{5}\right)^4 \left(\frac{4}{5}\right)^{6-4} = 15 \times \left(\frac{1}{5}\right)^4 \left(\frac{4}{5}\right)^2 = 0.0154$$

2. People who gets lots of vitamins by eating five or more servings of fresh fruits and vegetables each day have much lower death rates from colon cancer and lung cancer, according to many observational studies. These studies were so encouraging that two randomized controlled experiments were done. The treatment groups were given large doses of vitamin supplements, while the control group just ate their usual diet. One experiment looked at colon cancer; the other at lung cancer.

The first experiment found no difference in the death rate from colon cancer between the treatment group and the control group. The second experiment found that beta carotene (as a diet supplement) increased the death rate from lung cancer. True or false, and explain:

- (a) The experiments confirmed the results of the observational studies.

False

- (b) The observational studies could easily have reached the wrong conclusions, due to confounding – people who eat lots of fruit and vegetables have lifestyles that are different in many other ways too.

True

[TURN OVER]

- (c) The experiments could easily have reached the wrong conclusions due to confounding – people who eat lots of fruit and vegetables have lifestyles that are different in many other ways too.

False (the whole point of an experiment).

People who eat lots of fruit + veg may differ from those who don't in many other ways. Some other aspect of diet or lifestyle may be causing the observed effect. (it could even be something in fruit/veg other than vitamins)

3. A statistics professor buys a loaf of bread each week from the same bakery. The baker advertises the weight of the loaf as one pound (16 oz). Over the course of 20 weeks the professor records the weight of the loaves. They are (in oz, sorted into increasing order)

10.3, 11.7, 12.5, 13.4, 13.6, 14.,0 14.4, 14.5, 14.7, 15.0, 15.2, 15.4, 15.5, 15.6, 16.,0
16.4, 17.,0 17.4, 17.6, 18.7

- (a) Complete the table below, where the class interval includes the lower limit, but not the upper limit.

Class Interval (oz)	Frequency	percentage	percent-per-oz
10-12	2	10	5
12-14	3	15	7.5
14-16	9	45	22.5
16-18	5	25	12.5
18-20	1	5	2.5

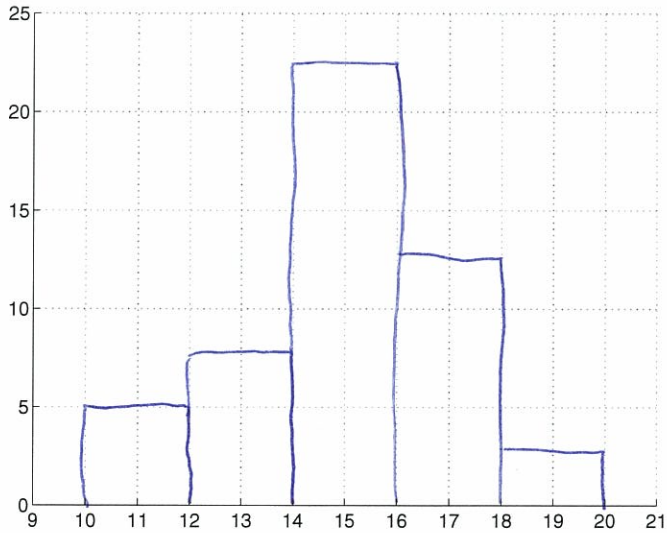
- (b) Sketch the histogram on the graph at the top of the page 3. Label the axes.
 (c) Does the histogram appear to follow the normal curve? Explain briefly.

approximately - yes.
 reasonably symmetric
 peaked in the middle.

- (d) The mean weight of the 20 loaves is 14.9oz, and the SD is 2.0oz. What is the median?

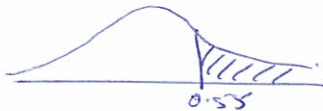
$$\frac{15.0 + 15.2}{2} = 15.1$$

[CONTINUED]



- (e) The professor tells the baker that he is selling underweight loaves. Assuming the weight of the loaves follows the normal curve, what percentage of loaves weigh at least the advertised 16oz?

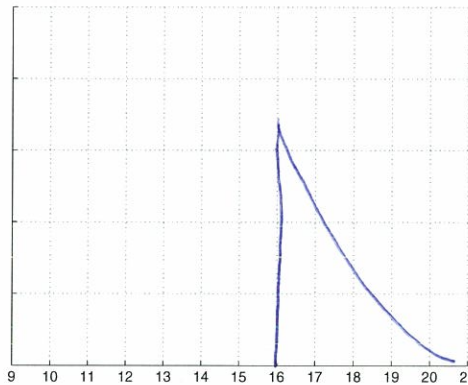
$$16 \text{ in standard units is } \frac{16 - 14.9}{2} = 0.55$$



$$\% \text{ is } \frac{1}{2} \times (100 - 41.77) \approx 29\%$$

- (f) The baker tells the professor that he has increased the weight of the loaves, but instead weighs loaves each morning until he finds one that weighs at least 16oz, which he then puts aside for the professor.

Sketch the histogram of the weights of the loaves the professor now buys.



- (g) Does the professor believe the baker? Explain why/why not.

No - the distribution of loaves the professor buys does not follow the normal curve (as it would if the distribution was as before, but with a larger mean) [TURN OVER]

4. True or false, and explain briefly –

(a) If you add 7 to each entry on a list, that adds 7 to the average.

True

(b) If you add 7 to each entry on a list, that adds 7 to the SD.

false - deviations from mean stay the same

(c) If you double each entry on a list, that doubles the average.

True

(d) If you double each entry on a list, that doubles the SD.

True - deviations from mean are doubled

(e) If you change the sign of each entry on a list, that changes the sign of the average.

True

(f) If you change the sign of each entry on a list, that changes the sign of the SD.

False - when the deviations are squared, the result is always positive (or zero)

5. Read the abstract of the paper "Alcohol Consumption and Male Erectile Dysfunction: An Unfounded Reputation for Risk" printed at the end of this exam paper.

(a) Was this a controlled experiment or an observational study?

observational study.

(b) The investigators used reply paid questionnaires sent to the subjects. Give **two** possible problems with this methodology.

self-selection on part of the respondents
no way of verifying truthfulness of the replies.

[CONTINUED]

(c) What confounding factors did the investigators consider?

heart disease ; smoking

(d) Can you conclude that alcohol consumption causes erectile dysfunction? Explain briefly.

No. An observational study can only show association, not causation.

6. A box contains red and blue marbles; there are more red marbles than blue ones. Marbles are drawn one at a time from the box, at random, with replacement. You win a dollar if a red marble is drawn more often than a blue one. There are two choices.

- (A) 100 draws are made from the box.
- (B) 200 draws are made from the box.

Choose one of the four options below; explain your answer.

- (a) A gives a better chance of winning.
- (b) B gives a better chance of winning.
- (c) A and B give the same chance of winning.
- (d) Can't tell without more information

with more draws, % reds is likely to be closer to the % in the box, therefore, above 50%

7. In roulette, once in a while, someone will bet \$1 on red; and, at the same time, someone else will bet \$1 on black. (Recall that there are 18 red slots, 18 black slots, and two green slots. You win if the ball ends up in one of the slots of the color you have chosen.) Suppose this pair of bets is made 100 times in the course of an evening.

- (a) The house will make money on 5 of the 100 pairs of bets, give or take 2 or so.
- (b) The net gain for the house from the 100 pairs of bets will be around \$10 give or take \$4 or so

House has $\frac{36}{38}$ chance to win/lose nothing, $\frac{2}{38}$ chance to win \$2

$$\frac{2}{38} \times 100 = 5.26 \approx 5$$

SE on number of wins [TURN OVER]

$$5 \pm \sqrt{100 \times \sqrt{\frac{36}{38} \times \frac{2}{38}}} = 2.23 \approx 2$$