Stat 10 Lew FINAL IS 12/10/03 8:00am-11:00am

**FINAL WILL BE HELD IN THE LECTURE HALL**

1. A study of 150 first year college students, selected at random after their first full year of college, gives the following results for high school ranking (RANK) first year GPA (grade point average) and high school SAT score:

Average GPA =3.19; Standard deviation GPA= 0.49
Average RANK= 2.04; Standard deviation RANK = 1.13
Average SAT = 1291; Standard deviation SAT = 163
Correlation coefficient for GPA and RANK= -.33
Correlation coefficient for GPA and SAT= .24
Correlation coefficient for RANK and SAT= -.42

Assume the SAT scores had a minimum of 910 and a maximum of 1580 and are normally distributed. RANK has a minimum of 0 and a maximum of 6 and is not normally distributed. GPA has a minimum of 1.56 and a maximum of 3.98 and it is not normally distributed.

(a) Of the 3 correlation coefficients given to you above, please identify which pair has the ~~highest~~ strongest correlation and which has the ~~lowest~~ weakest correlation.

STRONGEST = RANK AND SAT = −.42

WEAKEST = GPA AND SAT = .24

(b) A student is interested in regressing first year college GPA on SAT. Using the information at the top of the page, please find the regression equation. Clear identify the slope, intercept, x and y variables.

Y = GPA X = SAT slope = $r * \frac{SD_y}{SD_x} = .24\left(\frac{.49}{163}\right) = .0007$

intercept = $3.19 - (.0007 * 1291) \cong 2.26$

equation is $\underset{(Y)}{GPA} = \underbrace{2.26}_{\text{int.}} + \underbrace{.0007}_{\text{slope}} (\underset{X}{SAT})$

(c) Please interpret the values of slope and intercept you calculated in part (b) in plain English.

The intercept suggests that when SAT = 0 GPA is 2.26

The slope suggests that for a one-unit increase in SAT there is a .0007 increase in GPA

(d) Peter and Paul are USC undergraduates who were selected in this study. Peter had an SAT score of 1040 and Paul had an SAT score of 820, what are their predicted GPAs?

Peter = 2.26 + .0007(1040) ≅ 3.00

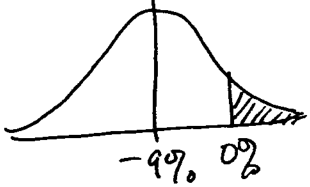
~~Paul = 2.26 + .0007(820) ≅ 2.85~~

Shouldn't predict Paul's, that's extrapolating.

Sorry, my mistake. VL

2. Lawyers frequently receive a “year-end bonus” because law firms are [illegible] among partners. There are approximately 1,000,000 lawyers in the U.S. and year 2002’s “year-end bonus”, when calculated as a percentage change of the 2001 “year-end bonus”, is normally distributed with a mean year-end bonus of -9% (a decrease, 2002 was a bad year compared to 2001) and a standard deviation of 16%. SHOW YOUR WORK FOR FULL CREDIT.

a) What proportion of lawyers received year-end 2002 bonuses that were as larger as or larger than their year-end 2001 bonuses?




$z = \frac{0 - -9}{16} = \frac{+9}{16} \doteq .56$ gives .2877 in the shaded area or 28.77%

$z = \frac{Y - \bar{Y}}{\sigma}$

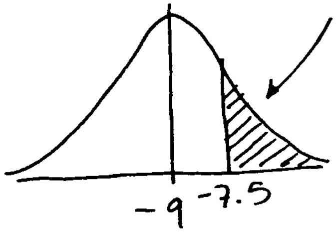
b) A simple random sample of 100 lawyers has an average year-end bonus at the 15[th] percentile, what is the actual value of that average? $n = 100$

solve for Y


corresponds to a $z = -1.04$

$z = \frac{Y - \bar{Y}}{\sigma/\sqrt{n}}$ so $-1.04 = \frac{Y - -9}{16/\sqrt{100}}$ $\approx -10.66$

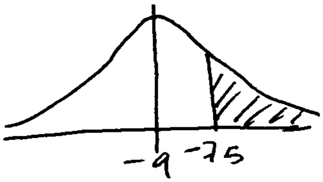
c) A simple random sample of 100 lawyers has an average year-end bonus of -7.5%, what is the chance of getting a sample average of -7.5% or higher?




$z = \frac{-7.5 - (-9)}{16/\sqrt{100}} = .9375 \approx .94$

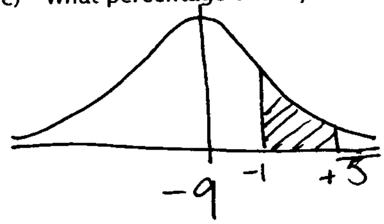
.1736 in the shaded area or 17.36%

d) What is the chance that a lawyer, selected at random, will have a year-end bonus of -7.5% or higher?




$z = \frac{-7.5 - (-9)}{16} = .09$ area is .4641 or 46.41%

e) What percentage of lawyers have year end bonuses between -1% and +5%?




$z_{+5} = \frac{+5 - (-9)}{16} = \frac{14}{16} \doteq .88$

$z_{-1} = \frac{-1 - (-9)}{16} = \frac{8}{16} \doteq .50$

subtract area Cs so

$.3085 - .1894 = .1191$ or 11.91%

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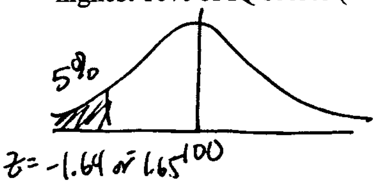
3. The IQ scores of adult humans (age 18 and over) is approximately normal with a mean of 100 and a standard deviation of 15.

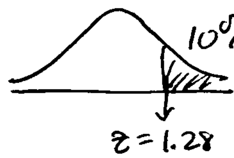
(a) How low is the lowest 5% of all IQ scores (that is, at or below what IQ score is the lowest 5%) How high is the highest 10% of IQ scores (that is, at or above what IQ Score is the highest 10%)?




so $\underset{(z)}{-1.64} = \frac{Y-\mu}{\sigma}$ $Y = 75.4$

or

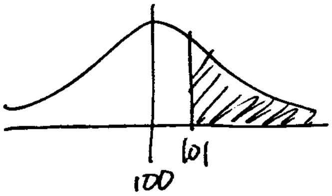
$-1.64 = \frac{Y-100}{15}$




so $1.28 = \frac{Y-100}{15}$

$Y = 119.2$

(b) A simple random sample of size 256 is drawn from the adult human population. What is the chance that the sample average will exceed 101?




$z = \frac{101-100}{15/\sqrt{256}} = \frac{1}{.9375} \approx 1.07$

area is .1423

or 14.23%

(c) How large of a sample would a researcher need to select to insure that he or she is within plus or minus 1 IQ point of the population mean IQ with 99% confidence?

margin of error

so they want $\bar{y}$ to be w/i $\pm$ 1 IQ point so it's like a rearranged confidence interval

i.e. $y \pm \underbrace{z\left(\frac{\sigma_Y}{\sqrt{n}}\right)}_{\text{set this part } = 1}$

$1 = \underset{(\text{or } 2.58)}{2.57}\left(\frac{15}{\sqrt{n}}\right)$ $\boxed{n \text{ is } 1486 \text{ (about)}}$

$z = 2.57$ or $2.58$ will give .5% in the tail ($\frac{1}{2}$ of 1%)

so solve for n

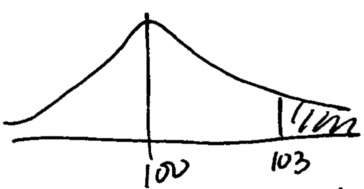
or $n = \frac{z^2 \cdot \sigma^2}{(\text{margin of error})^2} = \frac{2.57^2 \cdot 15^2}{1^2}$

(d) A simple random sample of 256 college students is drawn from the adult human population. The sample average is 103 and the sample standard deviation is 30. Please test the hypothesis that college students have higher IQ scores than the average human. State a null and an alternative hypothesis, perform a test, state a p-value and explain your result (do you reject or not reject the null and why). Use a 5% level of significance as your decision rule.

Null: College Student Average IQ is = 100

Alt.: College Student Average IQ is > 100

Test: $z = \frac{103-100}{15/\sqrt{256}} = \frac{3}{.9375} = 3.2$




p-value is .0007 and is < .05 so this is stat. sig. We reject the null. College students have higher than average IQs

4. Investors ask about the relationship between returns on investments (the money you make by investing your money) in the United States and on investments overseas. Below is a table of total returns on investments on U.S. and overseas stocks over a 10 year period.

| | Year | Overseas % Return | U.S. % Return |
|---|---|---|---|
| Average | 1991.5000 | 9.8100 | 16.0300 |
| Standard Deviation | 2.7386 | 15.6493 | 12.6810 |

(a) Suppose the correlation, r, of the U.S. and overseas returns is .3239. Please describe the relationship between U.S. and overseas returns in words, using r to make your description more precise.

4 r = .3239 the relationship is positive (so as US returns go up so do overseas returns) but WEAK an r = .3239 is closer to zero than 1.0

(b) Find the regression line of overseas returns on U.S. returns. Please interpret the values of the slope and of the intercept of this line.

Y = overseas X = US returns

slope = $.3239\left(\frac{15.6493}{12.6810}\right)$

= .3997

intercept is 9.81 − (.3997 * 16.03)
= 3.4025

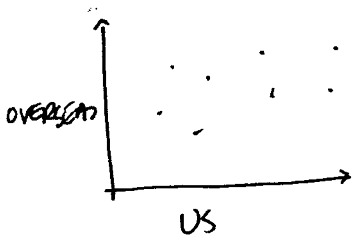
equation is Overseas (Y) = 3.4025 + .3997 (US returns X)

slope - for every 1% change in US returns overseas increases by .3997% Intercept - if US returns were zero overseas is 3.4025

( c) In 1993, the return on U.S. stocks was 10.1%, what was the predicted return on overseas stocks for that year? Suppose I told you that the actual return on Overseas Stocks that year was 32.9%? Why are they so different?

predicted 1993 = 3.4025 + .3997(10.1) = 7.43947

The correlation is weak and a straight line (regression) is not expected to pass through all of the points and there is some error.




This is a situation where the regression model is a poor predictor of Y given information on X.

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5. An investigator looks up the rainfall in a certain city on January 15 for the past 70 years. She finds the average rainfall on that day to be 0.30 inches and the SD to be about 0.14 inches. She then concludes that the interval from 0.25 to 0.35 inches is a 99.7% confidence interval for the average rainfall on January 15 in the city. Is this conclusion justified? Why or why not?

No. This is not the correct application of a confidence interval. A confidence interval attempts to estimate some unknown parameter from sample ~~to~~ information BUT it relies on the ability to repeatedly sample. Basically her data do not constitute a true sample as there ~~is~~ only one possible set of 70 Jan 15th s in that city. She should simply say " it's .30 on average w/ an SD = .14 " and leave confidence out.

6. The speed of light is measured 2,500 times by a new process. The average of these 2,500 measurements is 299,774 kilometers per second, with an SD of 140 kilometers per second. You may assume the 2,500 measurements can be treated as if were a random sample.

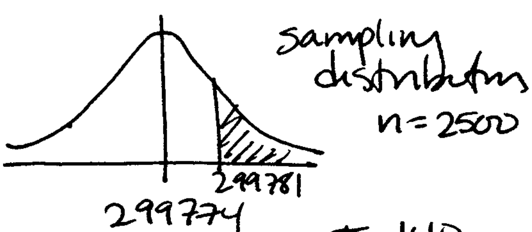
a.Find an approximate 95% confidence interval for the speed of light. (You may assume normality, with no bias.)

$$\underset{\bar{Y}}{299{,}774} \pm 1.96\left(\frac{140}{\sqrt{2500}}\right) \Rightarrow 299{,}774 \pm 5.49$$

b.Now the investigators determine the speed of light *by taking one single measurement* by the same procedure and get 299,781 kilometers per second. Is this a surprising result? Why or why not?

BAD

c.Now the investigators determine the speed of light by taking another sample of 2,500 the same procedure and get 299,781 kilometers per second. Is this a surprising result? Why or why not?




$$z = \frac{299781 - 299774}{140/\sqrt{2500}} \approx 2.5$$

$\sigma = 140$

$$\frac{\sigma}{\sqrt{n}} = \frac{140}{\sqrt{2500}}$$

area is .1003 ~ 10%

~~also~~ almost surprising, this only happens 1 in 10 times (samples)

7. Does salt cause high blood pressure? One large study was done at 52 centers in 32 counties. Each center recruited 200 subjects in 8 age-and sex- groups. Salt intake was measured, as well as blood pressure and several possible confounding variables. After adjusting for age, sex, and the confounding variables, 25 of the centers found a positive association between diastolic pressure and salt intake; 27 found a negative association. Do the data support the theory that salt causes high blood pressure? Answer yes or no, and explain briefly.

No. The data support the notion of ASSOCIATION. That is, the variables appear to be related - but the direction (pos. vs. neg.) is not clear as the centers have conflicting results. Also - we want to ask how were the subjects recruited.

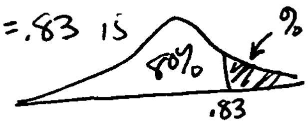
8. A study on pre-meds, selected at random, gives the following results for the medical college admissions test (MCAT) and undergraduate GPA (grade point average):

Average GPA: 3.3; Standard deviation = 0.4 Min. GPA = 2.5 Max. GPA = 4.3
Average MCAT: 10; Standard deviation = 1.1 Min MCAT=7.0 Max MCAT=13
Correlation coefficient = 0.65

a) Suppose the percentile of one student's GPA is at the $90^{th}$ percentile. Predict the student's percentile on the MCAT. The scatter diagram is football shaped and the MCAT and the GPA are normal.

If 90th percentile and NORMAL then $z = 1.28$ 90% ≤10%

So $\underset{(Y)}{z_{MCAT}} = r \underset{(X)}{z_{GPA}}$ and that is $(.65)(1.28) = .83 = \underset{(Y)}{z_{MCAT}}$

a $z = .83$ is  % is ~20% so the student is at the 80th percentile

b) Please construct the regression equation for MCAT on GPA. Please interpret the values of the slope and intercept in plain English.

Y X

slope: $(.65)\left(\frac{1.1}{0.4}\right) = 1.7875$ intercept $= (10) - (1.7875 * 3.3)$
$= 4.1013$

equation is MCAT = 4.1013 + 1.7875 (GPA) slope - for a one point increase in GPA, MCAT increases by 1.7875. If GPA were zero MCAT is ~4.1 (but this is a non-sense result)

c) Your wealthy cousin, a graduate of USC, is really, really dumb. He told you his GPA is a whopping 1.9. He's now thinking of going to medical school. What is his predicted MCAT score?

Should not calculate this, it's extrapolating. There is no data to support it b/c 1.9 is less than the minimum GPA listed above.

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9. The pregnancy duration of human females (age 18 and over) is approximately normal with a mean of 266 days and a standard deviation of 16 days. It is believed that older pregnant women have longer pregnancy durations. A simple random sample of 121 older pregnant women is drawn from the population of all pregnant women. The average pregnancy duration for the sample is 267 days and the sample standard deviation is 35.

(a) Please test the hypothesis that older women have longer pregnancy durations than the average woman. State a null and an alternative hypothesis, perform a test, state a p-value and explain your result (do you reject or not reject the null and why). Use a 5% level of significance as your decision rule.

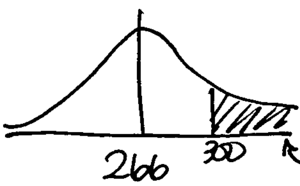
Null: Preg durations are equal to 266 days
AH: Preg. durations are > than 266 days

$z = \frac{267-266}{16/\sqrt{121}} \approx +.68$ so p-value $\approx .25$ or 25%

$.25 > .05$

SO DO NOT REJECT THE NULL. NOT STATISTICALLY SIGNIFICANT. OLDER WOMEN DO NOT TAKE LONGER

(b) What proportion of pregnancies have durations as long as or longer than 300 days?




$z = \frac{Y-\bar{Y}}{\sigma} = \frac{300-266}{16} = +2.13$

around 1.66%

(c) Suppose a researcher is only interested in studying the proportion of pregnancies that have durations as long as or longer than 300 days. How large of a sample would he or she have to select in order to properly invoke the Central Limit Theorem to create confidence intervals or test hypotheses about these 300+ day pregnancies?

If 1.66% are longer than 300 days and this is p
the q = 98.34 if $np \geq 10$ then n must be at least 603.

b/c $(603)(.0166) \approx 10$

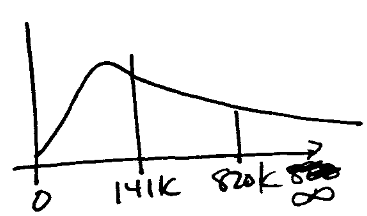
10. Here are two statistics on all persons who consider themselves computer programmers in 1999:

$820,000 dollars per year
$141,000 dollars per year

Which one of these numbers is the mean salary from computer programming and which one is the median salary from computer programming in 1999? Assume the samples were of good quality.

The mean is 820,000

The median is 141,000




Explain your choice in the space below. Be brief. This is not a long answer.

Reason that b/c salaries cannot be less than zero but they can be extremely high, the outliers are on the RIGHT side of the distribution and is right skewed so mean > median.

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11. High Bias and High Variance are both considered undesirable features of certain sample statistics (such as a sample mean for example). You are working with a team on a marketing study, a sample of size 100 is drawn. One of the variables you are interested in is the average time spent on the internet on any day. You plan to construct confidence intervals and perform some unspecified hypothesis tests. Studies always have problems, and today you have your choice: High Bias or High Variance. Which one would you rather deal with and why?

HIGH VARIANCE. Both are bad, but high variance can be addressed by gathering a larger sample (recall that if 2 samples are good, the larger of the two will be more precise in its estimates of the average etc. because $\frac{\sigma_Y}{\sqrt{n}}$ or $\sqrt{\frac{pq}{n}}$

BUT BIAS! No matter how big your sample gets (as long as it is not the same size as the population) it's bad if you fail to fixed the biasedness.

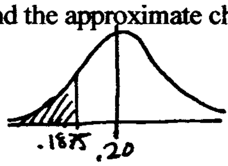
12. Los Angeles International Airport handles an average of 6,000 international passengers an hour. Suppose 80% can pass through primary security, but the rest are detained for interrogation by the FBI. And suppose the FBI can handle 1,500 passengers an hour without unreasonable delays for travelers and extra costs to the airlines (due to missed flights and connections).

a. Over break, it is expected that as many as 8,000 international passengers will arrive per hour. When that occurs, what is the expected proportion of passengers who will be detained?

20%, knowing nothing else, we expect 80% to pass, 20% to not

b. Referring to part a, find the approximate chance that less than 1,500 out of 8000 international passengers will be detained?

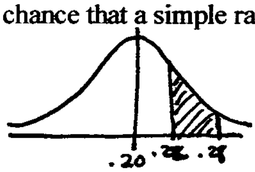
$\frac{1500}{8000} = .1875$




$z = \frac{.1875 - .2000}{\sqrt{\frac{(.20)(.80)}{8000}}} \approx -2.80$ area is .0026

chance of .0026

c. Suppose the FBI decides to randomly sample passengers in order to speed up the screening process. What is the chance that a simple random sample of 100 will have between 22 and 28 passengers detained by the FBI?




$z_{.28} = \frac{.28 - .20}{\sqrt{\frac{(.20)(.80)}{100}}} = \frac{.08}{.04} = +2$ area is .9772

shaded is .9772 − .6915

$z_{.22} = \frac{.22 - .20}{\sqrt{\frac{(.2)(.8)}{100}}} = \frac{.02}{.04} = .5$ area is .6915

$\boxed{= .2857}$

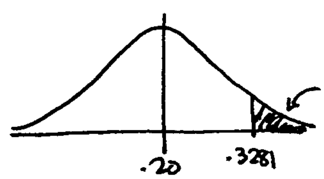
d. Certain ethnic/racial groups appear to be detained at much higher rates than others. Suppose a human rights organization sends 64 persons who appear to be of middle eastern origin through the airport and 21 are detained for interrogation. Please test the hypothesis that persons of middle eastern origin are detained in higher proportions than the typical traveler. State a null and an alternative hypothesis, perform a test, state a p-value and explain your result (do you reject or not reject the null and why). Use a 5% level of significance as your decision rule. You may treat the 64 as if it were a simple random sample and it is of reasonable size.

ll $H_0$: $p = .20$ Middle eastern origin are treated the same

lt $H_1$: $p > .20$ ~~treated~~ detained in higher proportion

$\frac{21}{64} = .3281$

Test: $z = \frac{.3281 - .2000}{\sqrt{\frac{(.20)(.80)}{64}}} = \frac{.1281}{.05} = +2.56$




p-value is .0052 and is less than .05 $z = +2.56$

REJECT THE NULL. STAT. SIG. The evidence suggests that these persons are being detained in higher proportions

13. A marketing survey interviewed 1000 adults selected at random from the population of all U.S. adults. Of the adults, 529 said they currently own a personal computer. When asked about the manufacturer of their computer, 144 of them said "Dull", 115 of them said "Compact", 175 of them said "some other company" and the rest of them said "I don't know". The mean time of ownership (in months) for the 529 was 12.9 with a standard deviation of 8.7.

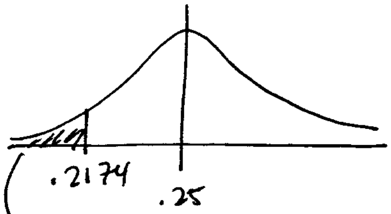
(a) A Compact executive saw the survey and is now upset, he believes that the survey was poorly done and argues that Compact's true market share is 25% (i.e. he thinks that 25% of all adults who own computers own a Compact) and cannot be nearly as low as the survey suggests.

Let's help the executive out. Please test the hypothesis that Compact's market share is actually 25%. Use a 5% level of significance as your decision rule. State the null hypothesis, the alternative hypothesis, perform a test, give a p-value, and state your conclusion in plain English: would you reject the null and on the basis of your test result do you also think the survey was poorly done?

Null: Compact actually has .25 or 25% $p = .25$
Alternative Compact has less than .25 or $p < .25$

Test

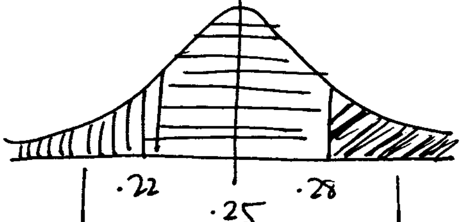
$\frac{115}{529} = .2174$ so $z = \dfrac{.2174 - .25}{\sqrt{\dfrac{(.25)(.75)}{529}}} = \dfrac{-.0326}{.0188} = -1.73$




p-value is .0418

$.0418 < .05$ so REJECT THE NULL
the difference is statistically significant, Compact has less than 25%

(b) Suppose Compact's true market share is REALLY 25%. What is the chance that among 529 computer owners you would get less than 22% of them saying they owned a Compact? What is the chance that you would get between 22% and 28% saying they owned a Compact? What is the chance that you would get at least 28% saying they owned a Compact?




$z_{.22} = \dfrac{.22 - .25}{\sqrt{\dfrac{(.25)(.75)}{529}}} = \dfrac{-.03}{.0188} = -1.59$

$z_{.28} = \dfrac{.28 - .25}{\sqrt{\dfrac{(.25)(.75)}{529}}} = \dfrac{.03}{.0188} = +1.59$

area $= .0559$

area $= .0559$

so 22-28% area is

$1.00 - (.0559 + .0559) = .8882$

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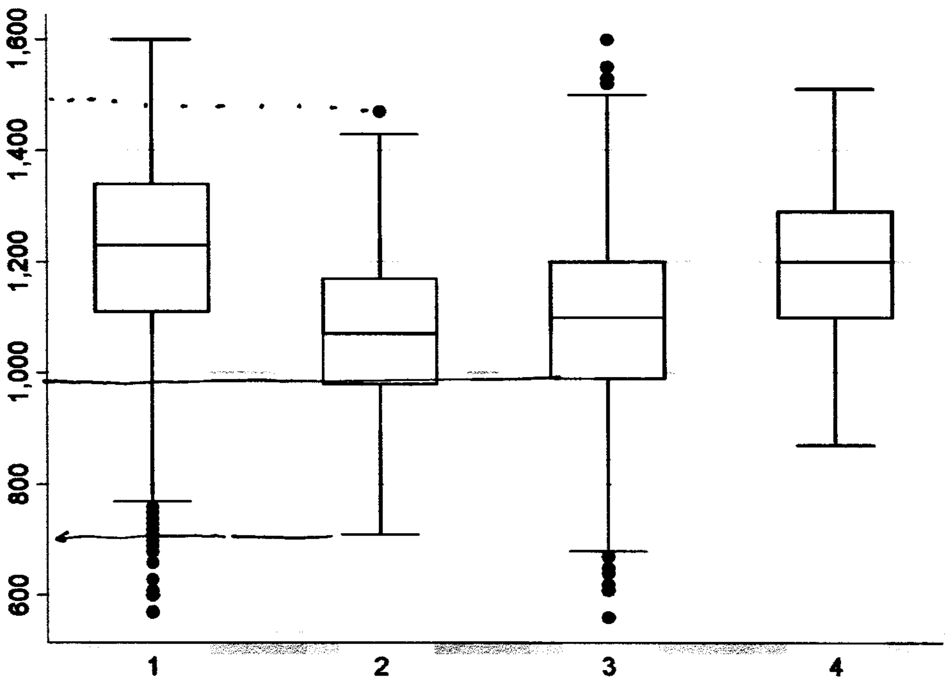


14. The horizontal axis should be labeled "GROUP" and the vertical axis should be labeled "POINTS". The dark dots should actually look like open circles or asterisks. Using the box plot shown above, please answer the following questions:

a) Is there enough information present to estimate the range for group 2? (circle one)

YES NO

If you answered "YES" please give an approximate or reasonable estimate of that value in the space below, if you answered "NO" please explain why it is not possible to estimate the range in this situation.

MAX MIN
~ 1500 − ~ 700 ≅ 800

b) Is there enough information present to estimate the interquartile range (IQR) or group 3? (circle one)

YES NO

If you answered "YES" please give an approximate estimate of that value in the space below, if you answered "NO" please explain why it is not possible to estimate the range in this situation.

75th 25th
~ 1200 − ~1000 ≅ 200

c) Which group appears to be the most left skewed? (circle one)

1 2 3 4 Not enough information

d) Which group has the highest median of the four groups ? (circle one)

1 2 3 4 Not enough information

e) Which group is the most symmetrical of the four groups ? (circle one)

1 2 3 4 Not enough information

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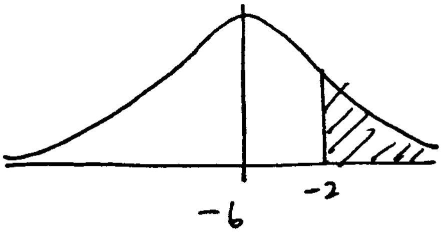
15. A number of socio-behavioral tests have been designed to measure the quality of social interactions of adult humans (age 18 and over) with other adult humans. One test, called the Chaplin Social Insight Test, evaluates how accurately a given adult subject appraises other adults. In an adult population used to develop the test, scores are approximately normally distributed with a mean of -6 and a standard deviation of 5. The range of possible scores are -31 to 10 and 68% of the population scored between a -11 and -1. A second test, called the Caminker-Harris Assimilation Test attempts to measure an adult's ability to assimilate in a new social environment. In an adult population used to develop the assimilation test, scores are also approximately normally distributed with a mean –4 and a standard deviation of 10. The range of possible scores are -64 to 56 and 68% of the population scored between a -14 and +6.

These two tests are used frequently at UCLA by researchers. Recently a sample of 100 UCLA students was drawn at random from the population of all UCLA students. The 100 students were given both the Chaplin Social Insight Test and the Caminker-Harris Assimilation Test. The sample mean for the Chaplin test was –4 and the sample standard deviation was 7. The sample mean for the assimilation test was 0 and the sample standard deviation was 12. UCLA researchers noted that the test scores for the sample of 100 students were not normally distributed.

Please use any relevant information from above to answer the following questions.

A) A randomly selected adult subject scores a -2 on the Chaplin Social Insight test. What proportion (or percentage) of the adult population has a higher score than he or she does?

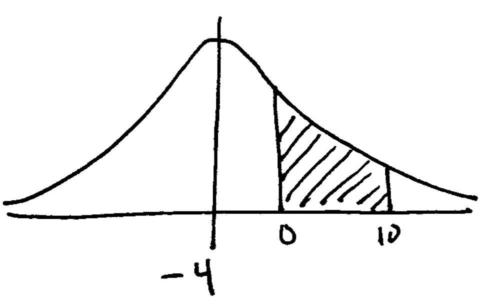



$z = \frac{-2-(-6)}{5} = \frac{4}{5} = {}^{+}.80$

area is .2119

or 21.19%

B) It has been demonstrated that excellent candidates for employment in international relations score between a 0 and a +10 on the Caminker-Harris Assimilation Test. What proportion (or percentage) of adult test takers score between a 0 and a +10?




$z_{+10} = \frac{10 - -4}{10} = 1.40$

$z_0 = \frac{0 - -4}{10} = {}^{+}.40$

area $^{+}1.40$ − area $^{+}.40$

$.9192 - .6554 = .2638$

or 26.38%

**FINAL WILL BE HELD IN THE LECTURE HALL**

**16. A student issued the following command for analysis variable FAMILYSEI**

```
. summarize familysei, detail

                           familysei
-------------------------------------------------------------
      Percentiles      Smallest
 1%            0              0
 5%         22.5              0
10%         28.2              0       Obs                1428
25%         37.3              0       Sum of Wgt.        1428

50%         63.5                      Mean            68.9631
                        Largest       Std. Dev.      39.68948
75%         92.3            175
90%        129.5          180.6       Variance       1575.255
95%        145.7          194.4       Skewness       .6213121
99%        166.9          194.4       Kurtosis       2.792152
```

Please answer the following questions based on the Stata results for variable FAMILYSEI. You may round the numbers given above to one or two decimal places. For example, 39.68948 can be rounded to 39.7 or 39.69

A. Using the Stata results above, please calculate the range, the interquartile range, and list the values of the quartiles (i.e. Q1, Q2 and Q3) (10 points)

Range $194.4 - 0 = 194.4$

IQR $92.3 - 37.3 = 55.0$

$Q_1$ 37.3

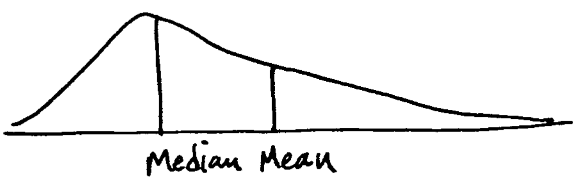
$Q_2$ 63.5

$Q_3$ 92.3

B. Is the distribution for this variable skewed? (circle one): YES NO (1 point)

Please justify your response in the space below. If you think it is skewed, please indicate the direction (left or right skewed) of the skewness. (4 points)

the Mean > Median so it's Right skewed




(also skewness statistic is positive suggesting RT. skewness)