STAT511 – Exam 1
Fall 2017

Honor Pledge: I have not given, received, or used any unauthorized assistance on this exam.

Signature:_____

Printed Name:_____

Instructions:
- **Open book, open notes, calculator required. No computers or cell phones.**
- **Time limit is 1 hour 50 minutes - strictly enforced!**
- If an answer is in the computer output, use it; don't calculate it by hand.
- Show your work where appropriate. Put your final answer in the box (if provided).
- Make explanations brief and legible.
- All questions are worth 4 points except where noted. Maximum score is 100.
- Computer input/output is provided at the end of the exam.
- The exam contains a total of 8 pages (including computer input/output).
- If you run out of space, you may use the blank area on page 6 or extra paper.

Questions 1 through 3 (Fill Weights): The weight of cans filled by a certain machine is normally distributed with mean 16.12 oz and standard deviation 0.18 oz. In other words, let Y be the random variable representing fill weight and assume $Y \sim N(\mu = 16.12, \sigma = 0.18)$. Giver your final answers to two decimal places.

1. What proportion of cans contain of <u>16oz or less</u>? In other words, find $P(Y \leq 16)$.

2. Find the <u>weight</u> such that 2% of cans will weigh <u>less</u> than this amount.

3. The process mean can be adjusted through calibration. To what <u>value should the mean</u> (μ) be set so that 2% of cans will weigh less than 16oz.

Questions 4 through 9 (PFC): A recent Denver Post article was titled "State mulls limits for PFCs" (9/18/17). (For the purposes of this exam, suppose the regulations are already in place.) The maximum allowable level of PFC is 70 ppt (parts per trillion) in groundwater. State agencies will take remedial action if it can be shown that the mean PFC is greater than 70 ppt. Suppose n = 61 ground water samples were randomly selected from a large aquifer. Select R output is shown below. Use alpha = 0.05.

Histogram of PFC

```
> length(PFC)
[1] 61
> mean(PFC)
[1] 87.47
> sd(PFC)
[1] 73.72
> min(PFC)
[1] 2.08
> median(PFC)
[1] 62.09
> max(PFC)
[1] 349.24
```
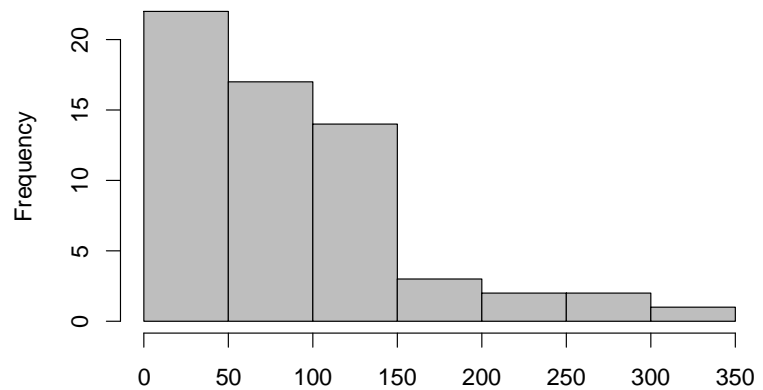
4. Based on the histogram, what is the shape of the distribution? Circle one answer, no need to justify.
   A. Bimodal
   B. Symmetric
   C. Skewed Left
   D. Skewed Right
   E. Other

5. Based on the histogram, if the Shapiro-Wilk test had been run for this data, what would you expect the result to be? Just circle one answer, no need to justify. (**2 pts**)
   A. Shapiro-Wilk p-value < 0.05
   B. Shapiro-Wilk p-value ≥ 0.05.

6. If <u>cumulative exposure</u> to PFC was of interest, would the mean or median be of more interest. Just circle one answer, no need to justify. (**2 pts**)

   Mean   Median

7. Regardless of your answer to the previous question, considering that "state agencies will take remedial action if it can be shown that the mean PFC is greater than 70 ppt", what are the hypotheses of interest? Be specific!

   H0:

   HA:

8. Using the summary statistics in the output, run a hypothesis test corresponding to the previous question. Give the test statistic, df, rejection rule and conclusion. Note: Run this test regardless of your answers to previous questions!

    A. (**4 pts**) Test Statistic =

    B. (**2 pts**) df =

    C. (**2 pts**) Reject H0 if

    D. (**2 pts**) Conclusion:

9. Give the name of a method that could be used to construct a confidence interval for <u>mean</u> PFC <u>without assuming normality</u>. Just state the method – no need to justify. (**2 pts**)

Questions 10 through 12 (Aldosterone 1): In the description below, <u>the investigator has made several errors.</u> An investigator is interested in the aldosterone blood levels in healthy dogs. She obtains a random sample of n = 10 healthy dogs for her study. She takes a 60ml blood sample from each dog, then runs lab work separately on three 20ml subsamples for each dog (for a total of 30 aldosterone values). She finds a sample mean of 100.3 and a sample standard deviation of 21.1 based on 30 values. After looking at the lab results, she decides to test H0: $\bar{y} = 100$ versus HA: $\bar{y} \neq 100$. The 95% CI with df = 29 is found to be (93.3, 107.2). Based on the CI she concludes that the true population mean is 100.

<u>Identify and briefly discuss</u> (or correct) <u>3 different errors</u> in the design, analysis, and conclusions above. Note: There may be more than 3 errors, but you only need to discuss 3 of them.

10. Error:

    Discuss/Correct:

11. Error:

    Discuss/Correct:

12. Error:

    Discuss/Correct:

Questions 13 through 15 (Aldosterone 2): Now suppose a new study is being planned to compare mean aldosterone levels in diseased dogs versus healthy controls. The investigator conjectures that the within group standard deviation is 15. They want 80% power to detect a meaningful difference (between means) of 20 with alpha = 0.05.

13. Using the information above, fill in the power.t.test code: (**8 pts**)

```
power.t.test(
power=0.80,
sig.level=0.05,
  (A)  delta=

  (B)  sd=

  (C)  alternative = (Circle one answer)

       one.sided        two.sided

  (D)  type= (Circle one answer)

       one.sample       two.sample
```

14. If the investigator wanted 90% power (instead of 80%), would the required <u>sample size</u> be higher or lower? (**2 pts**)

Lower   Higher

15. If the standard deviation was 10 (instead of 15), would the required <u>sample size</u> be higher or lower? (**2 pts**)

Lower   Higher

Questions 16 through 23 (Tips): A recent Denver Post article was titled "Why you tip as much, or as little, as you do" (8/30/17). The article describes a study where diners were randomly assigned to either receive a chocolate candy from their waiter or not. The data presented here is loosely based on that article. The **Tip** amount (as a percent of total bill) from each diner was recorded and compared for the two **Treatment** groups (Choc or NoChoc). (Randomization was done using a standard deck of cards.) We have observations for n_{Choc} = 28 diners and n_{NoChoc} = 31 diners. For convenience, let μ_{Choc} and μ_{NoChoc} represent the population mean tip for the two treatment groups. The R input and output are labeled **Tips**. Use $\alpha = 0.05$.

16. Is this an experiment or an observational study? Circle one answer, no need to justify. (**2 pts**)

Experiment   Observational Study

17. Based on <u>summary statistics</u> provided, would it be reasonable to <u>assume equal variances </u>(for purposes of the t-test)? Discuss.

18. A colleague looks at the summary statistics and suggests that you drop some of the observations for the NoChoc group to make the sample sizes for Choc and NoChoc the same. Do you agree with this suggestion?

Do you agree with this suggestion?   Yes   No

Discuss:

19. Without assuming normality, test whether there is a difference between the distributions of tip amount for Choc vs NoChoc. This should be a two-sided alternative.

p-value:

Conclusion:

20. True or False: The t.test() output (in **Tips** analysis) requires the assumption of equal variances. Just circle one answer – no need to justify. (**2 pts**)

TRUE   FALSE

21. Using R output and assuming normality, test H0: $\mu_{Choc} - \mu_{NoChoc} = 0$.

p-value:

Conclusion:

22. Considering the t.test() output and your answer to the previous question, what can be said about the 95% CI for $\mu_{Choc} - \mu_{NoChoc}$. Note that this CI has been "hidden" from the R output. Just circle one answer – no need to justify.
A. The 95% CI is completely below 0.
B. The 95% CI is completely above 0.
C. The 95% CI includes 0.
D. Not enough information to say.

23. Assuming normality, test HA: $\mu_{Choc} - \mu_{NoChoc} > 0$. Give the p-value corresponding to this one-sided alternative.

Questions continue on the next page…..

Questions 24 through 26: An investigator is interested in estimating some true population mean (μ). Based on a random sample of size n = 15 they find a 95% CI of (80, 90).

24. What is the sample mean ($\bar{y}$)?

> [blank box]

25. What is the 95% ME?

> [blank box]

26. What information would you want to look at in order to decide if the confidence interval is <u>valid</u>? Give at least <u>2 specific diagnostics</u> you would construct (if you had the raw data available).
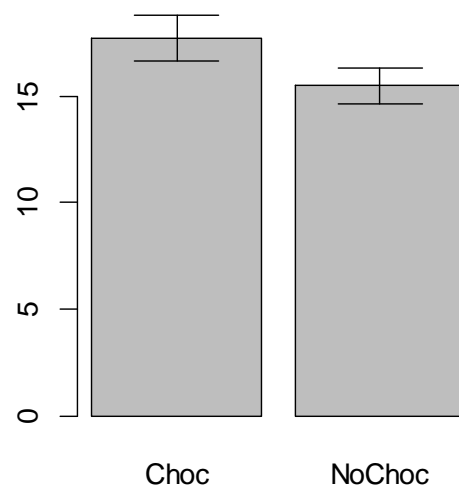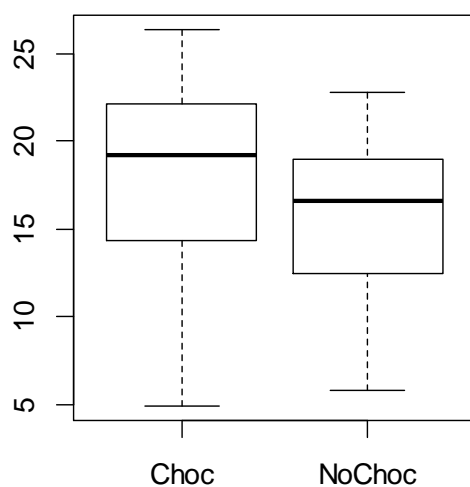
Tips (Questions 16 through 23)

```
library(plyr)
library(gplots)
str(TipsData)
SumStats <- ddply(TipsData, c("Trt"), summarize,
                  n = length(Tip),
                  mean = mean(Tip),
                  sd = sd(Tip),
                  SE = sd/sqrt(n))
SumStats
par(mfrow=c(1,2))
boxplot(Tip ~ Trt, data = TipsData)
with(barplot2(mean, plot.ci = TRUE, ci.l = mean-SE, ci.u = mean+SE, names
= Trt), data = SumStats)
t.test(Tip ~ Trt, data = TipsData)
wilcox.test(Tip ~ Trt, data = TipsData)
```

```
> str(TipsData)
'data.frame':      59 obs. of  2 variables:
 $ Trt: Factor w/ 2 levels "Choc","NoChoc": 1 1 1 1 1 1 1 1 1 1 ...
 $ Tip: num  12.3 22.1 24.3 23.6 21.3 ...
> SumStats <- ddply(TipsData, c("Trt"), summarize,
+                   n = length(Tip),
+                   mean = mean(Tip),
+                   sd = sd(Tip),
+                   SE = sd/sqrt(n))
> SumStats
     Trt  n     mean        sd        SE
1   Choc 28 17.70500 5.687775 1.074888
2 NoChoc 31 15.47377 4.651644 0.835460
> par(mfrow=c(1,2))
> boxplot(Tip ~ Trt, data = TipsData)
> with(barplot2(mean, plot.ci = TRUE, ci.l = mean-SE, ci.u = mean+SE, name
s = Trt), data = SumStats)
```


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Tips continued (Questions 16 through 23)

```
> t.test(Tip ~ Trt, data = TipsData)

        Welch Two Sample t-test

data:  Tip by Trt
t = 1.6389, df = 52.298, p-value = 0.1072
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 ███████████████████
sample estimates:
  mean in group Choc mean in group NoChoc
            17.70500             15.47377

> wilcox.test(Tip ~ Trt, data = TipsData)

        Wilcoxon rank sum test

data:  Tip by Trt
W = 550, p-value = 0.0795
alternative hypothesis: true location shift is not equal to 0
```