

## S520 Midterm 2: Takehome

**Upload your typed answers as a PDF file or Word document through the Assignments tab on Canvas by 11:59pm, Sunday, Nov 10th, 2019**

### Instructions and warnings:

- You may consult books and use computers, but may not discuss the problems with anyone.
- Write explanations for all your answers. Answers alone will not get credit. For questions where you use R, you must give R code, but the code alone is not a sufficient explanation. Include graphs where necessary.
- Conclusions should not just be reject or do not reject; they should be substantive conclusions about the issues under study.

### Example:

- "We reject the null hypothesis": **NOT MANY POINTS**
- "The  $P$ -value is 0.005. This means the data gives strong evidence that three-toed sloths have more toes than two-toed sloths.": **LOTS OF POINTS**

1. (18 points) **Handwashing and moral judgments**

A widely publicized psychology experiment (Schnall, Benton & Harvey (2008)) suggested that handwashing reduced the severity of moral judgments. However, since the experiment was performed on a small sample, researchers at Michigan State wished to replicate the experiment with more participants.

132 participants (students at Michigan State) were individually shown a distasteful scene involving heroin addicts from the movie *Trainspotting*. 63 of the students, randomly selected, were instructed to wash their hands afterward; the remaining 69 students were not. All 132 students then had six different scenarios described to them. For instance, the "trolley" scenario was as follows:

"You are at the wheel of a runaway trolley quickly approaching a fork in the tracks. On the tracks extending to the left is a group of five railway workmen. On the tracks extending to the right is a single railway workman. If you do nothing the trolley will proceed to the left, causing the deaths of the five workmen. The only way to avoid the deaths of these workmen is to hit a switch on your dashboard that will cause the trolley to proceed to the right, causing the death of the single workman. How wrong is it for you to hit the switch in order to avoid the deaths of the five workmen?"

For each scenario, they were asked to make a moral judgment on a scale of 1 to 7, where 1 meant "Nothing wrong at all" and 7 meant "Extremely wrong." The purpose of the experiment was to determine whether handwashing caused the students' moral judgments to be less severe (i.e. smaller numbers.) The file `handwashing.txt` on Canvas contains seven variables:

- `Condition` is a binary variable, where 1 indicates the student was in the handwashing group, and 0 indicates they were in the control group.
- `Dog`, `Trolley`, `Wallet`, `Plane`, `Resume` and `Kitten` give the students' responses to the six moral judgment questions. (If you wish, you can read all the questions at <https://osf.io/r7qbd/>, but this is not necessary to complete this exam.)

Say your data `handwashing.txt` is saved in D drive, then you can read and define the data in R as follows:

```
handwashing=read.table("D:/handwashing.txt",header=T)
```

The questions are on the next page.

- (a) What are the experimental units in this study? What measurements are taken on each unit? How many independent samples are there?
- (b) Perform a one-tailed significance test to study whether handwashing would lower the average answer to the trolley question. Carefully define hypotheses, calculate a  $P$ -value, and write a substantive conclusion.
- (c) Create a variable called **Total** that gives the total score on the six moral judgment questions for each individual. (Remember to give R code.) Draw labeled side-by-side boxplots (on the same plot) of **Total** for the handwashing and control groups.
- (d) Perform a one-tailed significance test to study whether handwashing would lower the average total score for the morality questions. Carefully define hypotheses, calculate a  $P$ -value, and write a substantive conclusion.
- (e) Find 95% confidence intervals for (i) the population mean of **Total** for handwashing, (ii) the population mean of **Total** for control, (iii) the difference in the population mean of **Total** between the two groups.
- (f) Which test will be more reliable for determining whether handwashing affects moral judgments – the test for **Trolley** in part (b), or the test for **Total** in part (d)? Explain.

2. A statistician who knows much more about cricket and rugby than basketball and football wishes to compare the size of NBA and NFL players. He randomly selects twelve players from each league and collects the data shown in the tables on the next page.

(a) (3 points) Find a 95% confidence intervals for:

- i. The *mean* height of all NBA players;
- ii. The *mean* height of all NFL players.

(b) (3 points) Find approximate 95% confidence intervals for:

- i. The *median* height of all NBA players;
- ii. The *median* height of all NFL players.

If you cannot achieve exactly 95% confidence, get as close to that level of confidence as you can.

- (c) (3 points) Suppose we are willing to assume that both NBA heights and NFL heights have close to normal distributions. Choose an appropriate statistical test for the null hypothesis that NBA players and NFL players have the same average height. Calculate the test statistic and  $P$ -value, and explain in words what you may conclude from this analysis.

NBA player	Position	Height (inches)	Weight (pounds)
Carmelo Anthony	Forward	80	230
Aron Baynes	Center	82	260
Matt Bonner	Forward/Center	82	240
Patrick Christopher	Guard	77	209
Norris Cole	Guard	74	170
Glen Davis	Forward/Center	81	289
Gorgui Dieng	Center	83	245
CleAnthony Early	Forward	80	219
Jrue Holiday	Guard	76	205
Jonas Jerebko	Forward	82	231
Andrew Nicholson	Forward	81	250
David West	Forward	81	240

Table 1: Heights and weights of a simple random sample of NBA players from the 2014-15 season. Data from [basketball-reference.com](http://basketball-reference.com).

NFL player	Position	Height (inches)	Weight (pounds)
Jahleel Addae	Defense	71	195
Tim Benford	Offense	71	196
Victor Butler	Defense	74	231
Hebron Fangupo	Offense	73	330
Anthony Fasano	Offense	76	255
Brian Hartline	Offense	74	180
Jason Hatcher	Defense	79	285
Cullen Jenkins	Defense	75	292
Darrin Reaves	Offense	70	210
Scott Simonson	Offense	77	249
Aldon Smith	Defense	77	255
Isaiah Trufant	Defense	68	170

Table 2: Heights and weights of a simple random sample of NFL players from the 2014-15 season. Data from [pro-football-reference.com](http://pro-football-reference.com).