Methods Homework 4

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# 1. The Abuse of Power

# 2.

## a. Power Calculations

### i. Known SD (by hand):

### ii. Unknown SD (with R):

power\_test <- power.t.test(n = 5, sd = 75, sig.level = 0.05, delta=100, type = "one.sample", alternative = "two.sided")  
power\_test

##   
## One-sample t test power calculation   
##   
## n = 5  
## delta = 100  
## sd = 75  
## sig.level = 0.05  
## power = 0.6141832  
## alternative = two.sided

power\_test$power

## [1] 0.6141832

## b. n Calculations

### i. Known SD (by hand):

### ii. Unknown SD (with R):

n\_test <- power.t.test(power=0.9, sd = 75, sig.level = 0.05, delta=100, type = "one.sample", alternative = "two.sided")  
n\_test

##   
## One-sample t test power calculation   
##   
## n = 8.072323  
## delta = 100  
## sd = 75  
## sig.level = 0.05  
## power = 0.9  
## alternative = two.sided

n\_test$n

## [1] 8.072323

## c. Smallest detectable change

### i. Known SD (by hand):

### ii. Unknown SD (with R):

# 90% power  
delta\_test\_90 <- power.t.test(n = 5,power = 0.9,sd = 75,sig.level = 0.05,type = "one.sample", alternative = "two.sided")  
delta\_test\_90

##   
## One-sample t test power calculation   
##   
## n = 5  
## delta = 147.4417  
## sd = 75  
## sig.level = 0.05  
## power = 0.9  
## alternative = two.sided

delta\_test\_90$delta

## [1] 147.4417

#80% power  
delta\_test\_80 <- power.t.test(n = 5,power = 0.8,sd = 75,sig.level = 0.05,type = "one.sample", alternative = "two.sided")  
delta\_test\_80

##   
## One-sample t test power calculation   
##   
## n = 5  
## delta = 126.1498  
## sd = 75  
## sig.level = 0.05  
## power = 0.8  
## alternative = two.sided

delta\_test\_80$delta

## [1] 126.1498

# 3.

## ia. Rejection Simulation (based on provided code):

set.seed(2345)  
# Set input values  
n <- 5  
mean <- 0  
sd <- 75  
numTrials <- 10000  
alpha <- 0.05  
# Set a counter to determine the number of rejected hypothesis tests  
count <- 0  
for(i in 1:numTrials){  
# Generate data  
y <- rnorm(n,mean,sd)  
# Perform test  
t <- t.test(y,alternative = "two.sided")  
count <- count + (t$p.value < alpha)  
}  
power <- count/numTrials  
power

## [1] 0.0498

The loop above generates 10,000 normal distributions with a mean of 0 and SD of 75. Then it performs a t-test on each distribution to see if the distribution’s mean is different from 0. If the p-value of the t-test is below our significance level of 0.05, the loop adds to the counter. Then, you divide the number of times that the mean was different from 0 by the number of simulations, to get the proportion of times the null hypothesis was rejected. The result is 0.0498, or about 5%, which is exactly what we’d expect.

## ib. Power Simulation (based on provided code):

set.seed(1796)  
# Set input values  
n <- 5  
mean <- 100  
sd <- 75  
numTrials <- 10000  
alpha <- 0.05  
# Set a counter to determine the number of rejected hypothesis tests  
count <- 0  
for(i in 1:numTrials){  
# Generate data  
y <- rnorm(n,mean,sd)  
# Perform test  
t <- t.test(y,alternative = "two.sided")  
count <- count + (t$p.value < alpha)  
}  
# Power = proportion of rejections  
power <- count/numTrials  
power

## [1] 0.613

The answer above is closest to 2.a.ii, which was calculating power with an unknown standard deviation. Power is the probability that we reject the null hypothesis given that the alternative hypothesis is true. In other words, the probability of finding a difference if it exists. So the result above is pretty much exactly what we would expect based on the power calculation in 2.a.ii.

## iii.

To estimate the required sample size for a given power, you could take the above for loop and run it for a range of values for n. Once you reached a value of n that resulted in a power of 0.9, you would have a decent estimate for your answer. You could also do the same thing for various values of mean (with a fixed n), in order to determine the smallest detectable difference.