Lsn_7_AY23

Clark

Admin

Power

Recall, in MA206 we tested Hypothesis such as:

$H_0 : \mu = \mu_0$ vs $H_a : \mu \neq \mu_0$

Assuming that H_0 is true, we created a standardized statistic:

$$t = \frac{\bar{X} - \mu_0}{s/\sqrt{n}}$$

Which looks like:

Using $\alpha = 0.05$ our *Rejection Region* can be generated, which gives the values of t that we would conclude $\mu \neq \mu_0$ for. Note that if $\mu = \mu_a$ we *should* reject H_a, however there is a chance that we will not:

This region gives the probability of committing a Type-II error for $\mu = \mu_a$. Statistical power is 1-P(Type-II error) or the probability that the researchers find evidence for the alternative hypothesis when the alternative hypothesis is true.

Note that in order to actually find Power or Type-II error we need to specify a value of μ_a. Going back to our picture we see:

So the value chosen for μ_a impacts Power, another thing that impacts Power is n.

For a two-sample or one-sample t-test, finding power in R is straight forward with the command `power.t.test`. Here we have to input n, $\Delta = |\mu_0 - \mu_a|$ which can be thought of as how big of an effect do we want to observe, s, and/or power. Note that one of these must be blank and is solved for. For instance, if we want to observe an effect of 1 and we assume $s = 1$, and we have $n = 10$ observations for group and we are testing $H_0 : \mu_1 = \mu_2$ vs $H_a : \mu_1 \neq \mu_2$ we can run

```
power.t.test(n=10,delta=1,sd=1,power = NULL,type="two.sample",
             alternative="two.sided")
```

```
##
##      Two-sample t test power calculation
##
##               n = 10
##           delta = 1
##              sd = 1
##       sig.level = 0.05
##           power = 0.5619846
##     alternative = two.sided
##
## NOTE: n is number in *each* group
```

And we see that the power associated with this test is 0.56, or the probability of committing a Type-II error in this instance is 0.44. If we wwant to determine how big of a sample we would need to have 80 % power we would run:

```
power.t.test(n=NULL,delta=1,sd=1,power=0.8,type="two.sample",
             alternative="two.sided")
```

```
##
##      Two-sample t test power calculation
##
##               n = 16.71477
##           delta = 1
##              sd = 1
##       sig.level = 0.05
##           power = 0.8
##     alternative = two.sided
##
## NOTE: n is number in *each* group
```

To see that we would need 17 people in each group.

The same thing can be done with ANOVA tests using `library(pwr)` which must be installed.

The function `pwr.anova.test` can then be used in a similar way. The only tricky thing is that it relies on an effect size not given by R^2 but rather given by $f = \sqrt{R^2/(1-R^2)}$. This value is called Cohen's f^2, which is different than our F statistic. For two samples there's a similar value called Cohen's d statistic which is found via $\frac{\bar{x}_1 - \bar{x}_2}{s}$. Using Cohen's f we can find power via:

```
library(pwr)
R2=.1
f=sqrt(R2/(1-R2))
pwr.anova.test(f=f,k=5,n=10)
```

```
##
##      Balanced one-way analysis of variance power calculation
##
##               k = 5
##               n = 10
##               f = 0.3333333
##       sig.level = 0.05
##           power = 0.3968709
##
## NOTE: n is number in each group
```

Which matches Table 1.6.4. We can then change:

```
R2=.3
f=sqrt(R2/(1-R2))
pwr.anova.test(f=f,k=5,n=10)
```

```
##
##      Balanced one-way analysis of variance power calculation
##
##               k = 5
##               n = 10
##               f = 0.6546537
##       sig.level = 0.05
##           power = 0.9574163
##
## NOTE: n is number in each group
```

Or change People within group

```
R2=.1
f=sqrt(R2/(1-R2))
pwr.anova.test(f=f,k=5,n=20)
```

```
##
##      Balanced one-way analysis of variance power calculation
##
##               k = 5
##               n = 20
##               f = 0.3333333
##       sig.level = 0.05
##           power = 0.7431771
##
## NOTE: n is number in each group
```