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Power and sample size calculation for t test in R

We know how to compute power and determine sample size for Normal (z) tests and confidence intervals.
It's a bit harder to do that by hand for a t distribution, but there is a powerful R function we can
use, called power.t.test() that makes it easy.

To use it, we need to know (or at least guess) a few things.  We can give R values for all but one of
several quantities, and R can determine the missing one for us.

Suppose we want to know the power that a t-test has for detecting a difference as large as 1 unit
from zero if the standard deviation is 3 units, we have a sample of n = 20, and we are testing with
alpha = .05 .

> power.t.test( 20 , 1 , 3 , .05 , NULL , type = "one.sample" )

     One-sample t test power calculation

              n = 20
          delta = 1
             sd = 3
      sig.level = 0.05
          power = 0.2931601
    alternative = two.sided

So we have only a 29% chance of detecting en effect that size.

How large a sample would we need to have power .8?

> power.t.test( NULL , 1 , 3 , .05 , .8 , type = "one.sample" )

     One-sample t test power calculation

              n = 72.58407
          delta = 1
             sd = 3
      sig.level = 0.05
          power = 0.8
    alternative = two.sided

We need 73 (round up) to be reduce the Type II error risk to 20%.

How large an effect could we detect with 80% power with out original sample size?

> power.t.test( 20 , NULL , 3 , .05 , .8 , type = "one.sample" )

     One-sample t test power calculation

              n = 20
          delta = 1.981323
             sd = 3
      sig.level = 0.05
          power = 0.8
    alternative = two.sided

About 2 units (2/3 of a standard deviation).

It also works for a two-sample problem; the default is actually the two-sample case.

Suppose we want to detect a 1-unit difference in means between groups with standard deviation 3 in
both groups, again we assume alpha = .05 and want power .8.

> power.t.test( NULL , 1 , 3 , .05 , .8 )

     Two-sample t test power calculation
```

```
              n = 142.2466
          delta = 1
             sd = 3
      sig.level = 0.05
          power = 0.8
    alternative = two.sided

 NOTE: n is number in *each* group
```

That is 143 subjects per group, or 286 total.

How large must a difference be for us to detect it with 80% power if we can only afford 20 subjects per group?

```
> power.t.test( 20 , NULL , 3 , .05 , .8 )

     Two-sample t test power calculation

              n = 20
          delta = 2.727392
             sd = 3
      sig.level = 0.05
          power = 0.8
    alternative = two.sided

 NOTE: n is number in *each* group
```

We can detect effects no smaller than about .9 standard deviations under those conditions.

Here is example 7.9 from p. 434.

```
> power.t.test( 20 , 1 , 1.5 , .05 , NULL , type = "one.sample" , alternative = "one.sided" )

     One-sample t test power calculation

              n = 20
          delta = 1
             sd = 1.5
      sig.level = 0.05
          power = 0.8902459
    alternative = one.sided
```

and here is example 7.23 from p. 478.

```
> power.t.test( 45 , 5 , 7.4 , .01 , NULL , alternative = "one.sided" )
     Two-sample t test power calculation

              n = 45
          delta = 5
             sd = 7.4
      sig.level = 0.01
          power = 0.7965037
    alternative = one.sided

 NOTE: n is number in *each* group
```