Power Analysis in R

The "asbio" package contains a number of useful biostatistical tools. It was written for the textbook "Foundational and Applied Statistics for Biologists using R", by K. Aho.

In particular, we can use "asbio" to compute the power of Z-tests and the required sample size needed to attain a desired power. For this, we have to specify

- the type of the test (one- or two-sided),
- the effect size, as an absolute value of the difference, $|\theta-\theta_0|$,
- the standard deviation σ, which has to be known for the Z-test,
- the level of significance α,
- either the sample size or the desired power. If you enter the sample size, "asbio" will compute the power. If you enter the desired power, you will get the required sample size n.

Power analysis.

Example. Calculate the power of a Z-test for H_0: $\theta = 5$ vs H_A: $\theta < 5$ for the parameter $\theta = 4$, given the sample size 100, significance level 0.05, and the standard deviation 17. Note here that the effect size is $|\theta-\theta_0| = 1$, the parameter difference that we aim to detect with our test.

```
> power.z.test(sigma=17,n=100,alpha=0.05,effect=1,test="one.tail")
$sigma
[1] 17

$n
[1] 100

$power
[1] 0.1453429

$alpha
[1] 0.05

$effect
[1] 1

$test
[1] "one.tail"
```

The power is 0.1453. We can suppress the rest of the output by picking the power variable from it:

```
> power.z.test(sigma=17,n=100,alpha=0.05,effect=1,test="one.tail")$power
[1] 0.1453429
```

A two-sided test will have an even lower power because the significance level gets divided by two:

```
> power.z.test(sigma=17,n=100,alpha=0.05,effect=1,test="two.tail")$power
```

```
[1] 0.08507396
```

However, a bigger difference would be easier to detect:

```
> power.z.test(sigma=17,n=100,alpha=0.05,effect=3,test="two.tail")$power
[1] 0.4225954
```

Sample size calculation.

Back to the original situation, what sample size can guarantee the power of 0.8?

```
> power.z.test(sigma=17,power=0.8,alpha=0.05,effect=1,test="one.tail")$n
[1] 1786.759
```

We need at least 1787 participants. Note that we replaced n by power in the R code and printed n only.

Power analysis for t-tests.

Asbio also has power.t.test for t-tests. The arguments have different names though, matching the command power.z.test of the "stats" package, which is a part of basic R.

To compute power, use

```
> power.t.test(sd=17,n=100,sig.level=0.05,delta=3,alternative="two.sided",type="one.sample")

     One-sample t test power calculation

              n = 100
          delta = 3
             sd = 17
      sig.level = 0.05
          power = 0.4159054
    alternative = two.sided
```

To compute the sample size, use

```
> power.t.test(power=0.8,sd=17,sig.level=0.05,delta=3,alternative="two.sided",type="one.sample")

     One-sample t test power calculation

              n = 253.9637
          delta = 3
             sd = 17
      sig.level = 0.05
          power = 0.8
    alternative = two.sided
```

Syntax	power.z.test	power.t.test
Significance level	alpha	sig.level
One-sided vs two-sided	test	alternative
Standard deviation	sigma	sd
Detectable difference	effect	delta

Power	power	power
Sample size	n	n