



Study Coordination Center
Clinical Trial Unit

How sensitive is your power?

Beyond calculating sample size

Thomas Fabbro

supported by:

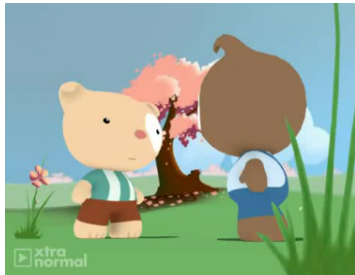


SCHWEIZERISCHER NATIONALFONDS
ZUR FÖRDERUNG DER WISSENSCHAFTLICHEN FORSCHUNG

Table of contents

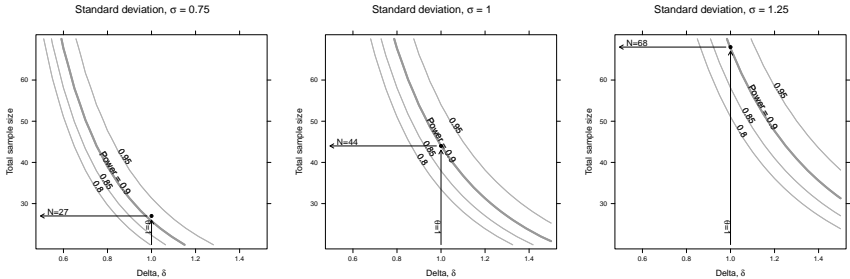
- 1 About asking the right question
- 2 About giving a better answer
- 3 The “power” package
- 4 Semiparametric resampling

About asking the right question



“How many subjects do I need to recruit, assuming a difference of $\delta = 1$ between two groups and a standard deviation of $\sigma = 1$?”
(Power of 90%, Level of Significance of 5%)

About giving a better answer



... and a thorough description of the calculation.

But the grant is due tomorrow...

The “power” package

The package contains several classes and methods aiming to provide fast and reliable tools for addressing important points *beyond* sample size.

- Sensitivity of sample size with respect to
 - a continuous parameter, called “theta” (e.g. δ),
 - a categorical or continuous parameter, called “xi” (e.g. σ),
 - the power.
- Methods for addressing information from the calculation for writing reports with Sweave.
- Mechanism for calculating the power using a simulation approach.

The "power" package

```
psi <- powPar(delta = seq(from = 0.5, to = 1.5, by = 0.05),  
             group.sd = c(0.75, 1, 1.25),  
             n = seq(from = 20, to = 50, by = 2),  
             theta.name = "delta",  
             xi.name = "group.sd")
```

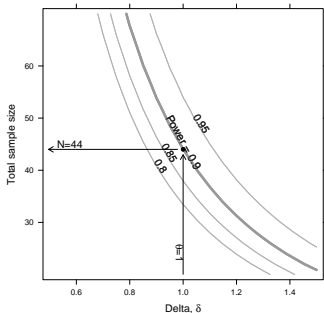
```
powFun <- function(psi) {  
  power.t.test(n = n(psi)/2,  
              delta = theta(psi),  
              sd = xi(psi))$power  
}
```

```
calc <- powCalc(psi, statistic = powFun)
```

```
ex <- powEx(theta = 1, xi = 1)
```

```
pow <- merge(calc, ex)
```

```
plot(pow)
```



The “power” package

For writing reports a method called “tex” allows to extract information. Currently these are

- the power used for the example,
- the theta and xi used for the example,
- the number of subjects needed for evaluation,
- the number of subjects that should be recruited, taking into account the proportion of expected drop-outs,
- and with the argument “resample”, a description of the sampling procedure and the number of resamples.

Semiparametric resampling

If data from a pilot study is available, a semiparametric resampling can be used to account

- non-parametrically for available data
- and parametrically for an effect size, e.g. a shift in location.

An idea by Davison and Hinkley, *Bootstrap Methods and their Application*, Cambridge Series in Statistical and Probabilistic Mathematics, 1997.

Semiparametric resampling

Calculating the power for the null hypothesis, $H_0 : \theta = 0$, using the Wilcoxon test, where θ is a shift in location and the underlying distribution F is unspecified.

- Pool $F(g_1)$, and $F(g_2 - \hat{\theta})$ to \hat{F} , where $\hat{\theta}$ is the difference in sample medians between group one and two.
- Sample n_1 subjects from \hat{F} .
- Sample n_2 subjects from \hat{F} and add θ to each.
- Calculate a test statistic t^* with R repetitions.
- Calculate the proportion of successful repetitions.

Semiparametric resampling

```
psi <- powPar(pilot = pilot.data,
             delta = seq(from = 0.5, to = 1.5, by = 0.05),
             n = seq(from = 10, to = 30, by = 2),
             theta.name = "delta")

powFun <- function(psi){
  a <- sample(pp(psi, "pilot"), size = n(psi)/2, replace = TRUE)
  b <- sample(pp(psi, "pilot"), size = n(psi)/2, replace = TRUE) + theta(psi)
  return(wilcox.test(a, b)$p.value < 0.05)
}

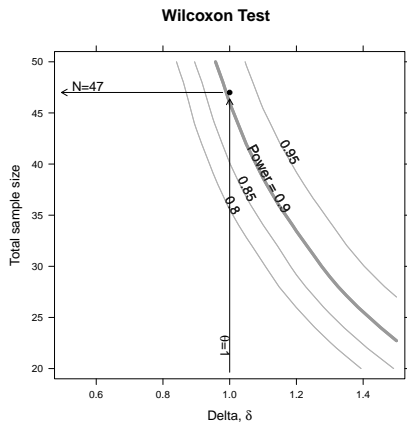
calc <- powCalc(psi, statistic = powFun, type = "resample", n.iter = 10000)

ex <- powEx(theta = 1)

pow <- merge(calc, ex)

plot(pow)
```

Semiparametric resampling



Comparing Wilcoxon Test and t Test

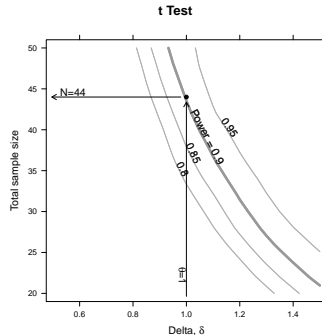
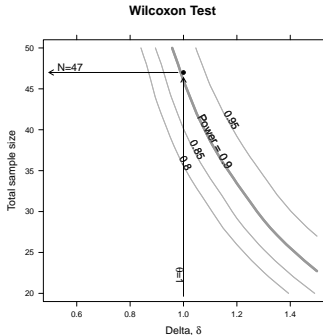
```
psi <- powPar(pilot = pilot.data,
             delta = seq(from = 0.5, to = 1.5, by = 0.05),
             n = seq(from = 10, to = 30, by = 2),
             theta.name = "delta")

powFun <- function(psi){
  a <- sample(pp(psi, "pilot"), size = n(psi)/2, replace = TRUE)
  b <- sample(pp(psi, "pilot"), size = n(psi)/2, replace = TRUE) + theta(psi)
  w <- wilcox.test(a, b)$p.value < 0.05
  t <- t.test(a, b)$p.value < 0.05
  return(c(w, t))
}

calc <- powCalc(psi, statistic = powFun, type = "resample", n.iter = 10000)

ex.w <- powEx(theta = 1, endpoint = "w")
ex.t <- powEx(theta = 1, endpoint = "t")
```

Comparing Wilcoxon Test and t Test



Acknowledgements and more about "power"

I would like to thank the statisticians of the Clinical Trial Unit, CTU, for their useful comments:

- Nicole Bruni
- Stefanie von Felten
- Thomas Zumbrunn

The "power" package is available at:

- power.r-forge.r-project.org