

# Simulating NHST and TOST

```
options(scipen=999)
library(knitr)
opts_chunk$set(tidy.opts=list(width.cutoff=60), tidy=TRUE)
```

## Simulating one-sample t-tests

```
require(TOSTER)

## Loading required package: TOSTER
n <- 50 #set sample size
low_eqbound = -0.3
high_eqbound = 0.3
sd_true <- 1
m_true <- 0
mu <- 0
alpha <- 0.05

require("TOSTER")
n <- powerTOSTone(alpha = alpha, statistical_power = 0.8, low_eqbound_d = -low_eqbound,
                    high_eqbound = 0.3)

## The required sample size to achieve 80 % power with equivalence bounds of 0.3 and 0.3 is 96
##
n <- ceiling(n)

nSims <- 1000000 #number of simulated experiments
pttest <- numeric(nSims) #set up empty container for all simulated p-values
ptost <- numeric(nSims) #set up empty container for all simulated p-values
tlist <- numeric(nSims) #set up empty container for all simulated p-values
p1list <- numeric(nSims) #set up empty container for all simulated p-values
p2list <- numeric(nSims) #set up empty container for all simulated p-values
LLlist <- numeric(nSims)
ULLlist <- numeric(nSims)

for (i in 1:nSims) {
  # for each simulated experiment
  x <- rnorm(n = n, mean = m_true, sd = sd_true) #Simulate data with specified mean, standard deviation
  m <- mean(x)
  sd <- sd(x)
  degree_f <- n - 1
  t1 <- (m - mu - low_eqbound)/(sd/sqrt(n)) # t-test
  p1 <- pt(t1, degree_f, lower = FALSE)
  p1list[i] <- p1
  t2 <- (m - mu - high_eqbound)/(sd/sqrt(n)) #t-test
  p2 <- pt(t2, degree_f, lower = TRUE)
  p2list[i] <- p2
```

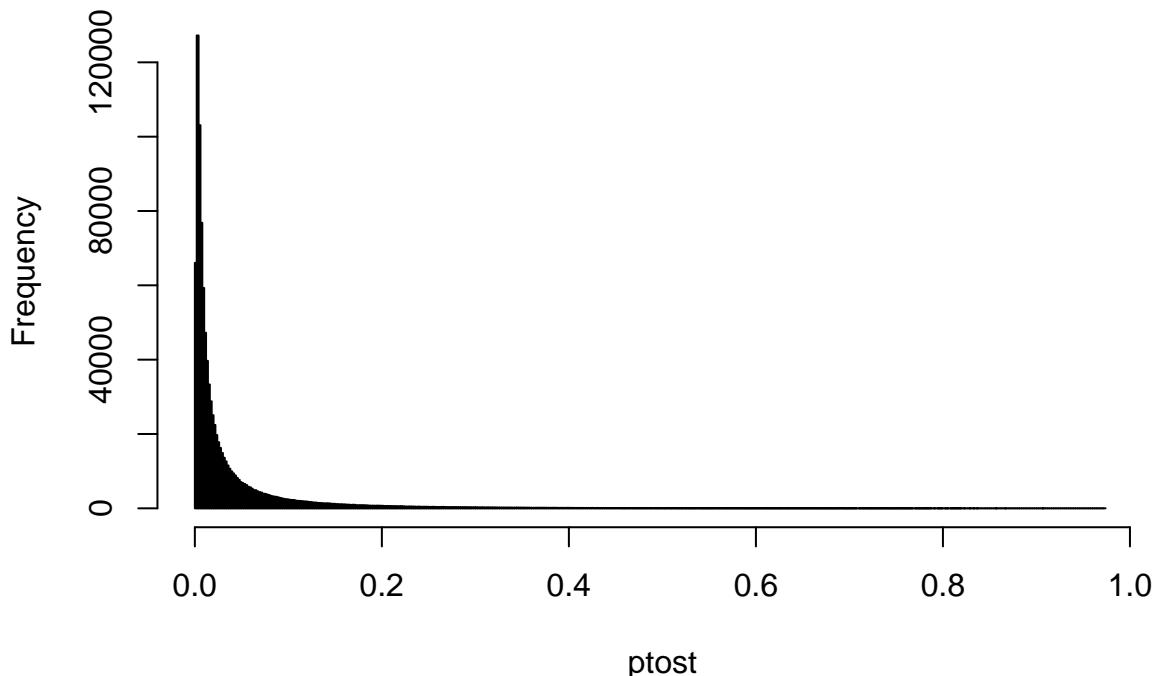
```

t <- (m - mu)/(sd/sqrt(n))
tlist[i] <- t
pttest[i] <- 2 * pt(-abs(t), df = degree_f)
LL90 <- (m - mu) - qt(1 - alpha, degree_f) * (sd/sqrt(n))
LLLlist[i] <- LL90
UL90 <- (m - mu) + qt(1 - alpha, degree_f) * (sd/sqrt(n))
ULLlist[i] <- UL90
ptost[i] <- max(p1, p2)
ttost <- ifelse(abs(t1) < abs(t2), t1, t2) #Get lowest t-value for summary TOST result
}

# P-value distribution TOST
hist(ptost, breaks = 500, xlim = c(0, 1))

```

**Histogram of ptost**



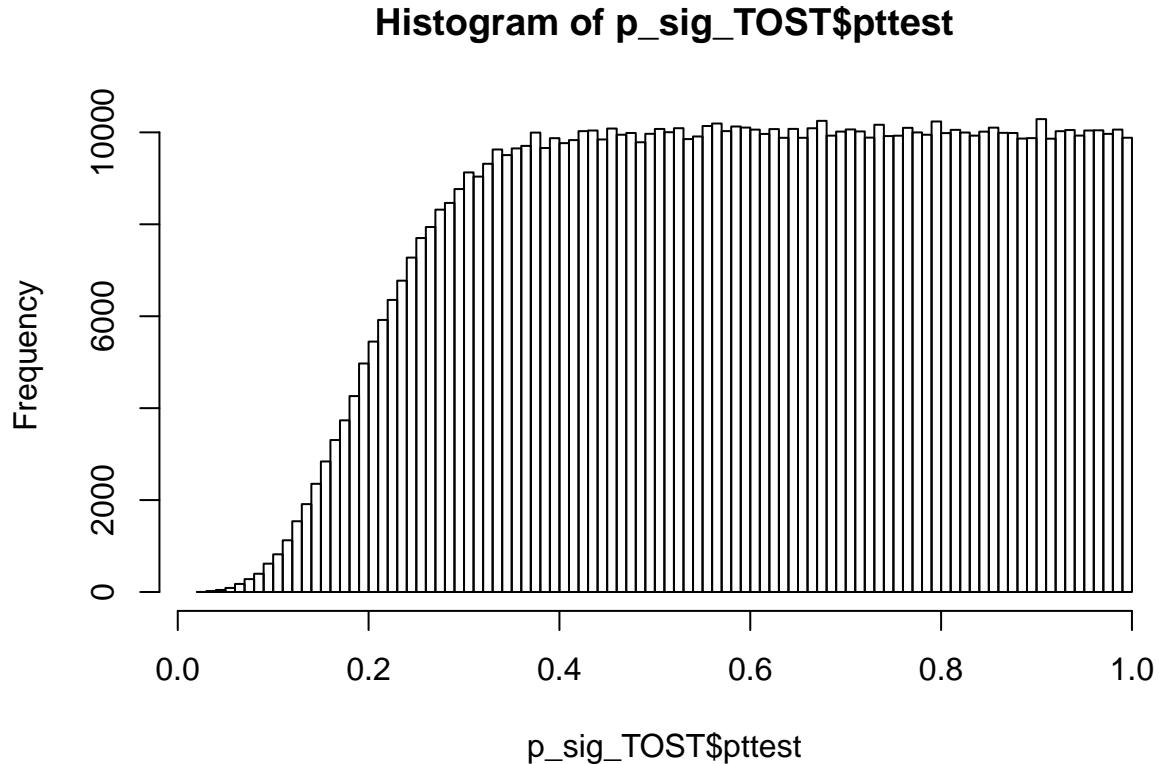
```

sum(ptost < 0.05)/nSims #Power for TOST
## [1] 0.797226
sum(LLlist >= low_eqbound & ULLlist <= high_eqbound)/nSims #Same power or Type 1 error, now based on CI
## [1] 0.797226
# Combine p-values from TOST and NHST

p <- data.frame(ptost, pttest)
# look only at significant TOST results
p_sig_TOST <- p[which(ptost < alpha), ]

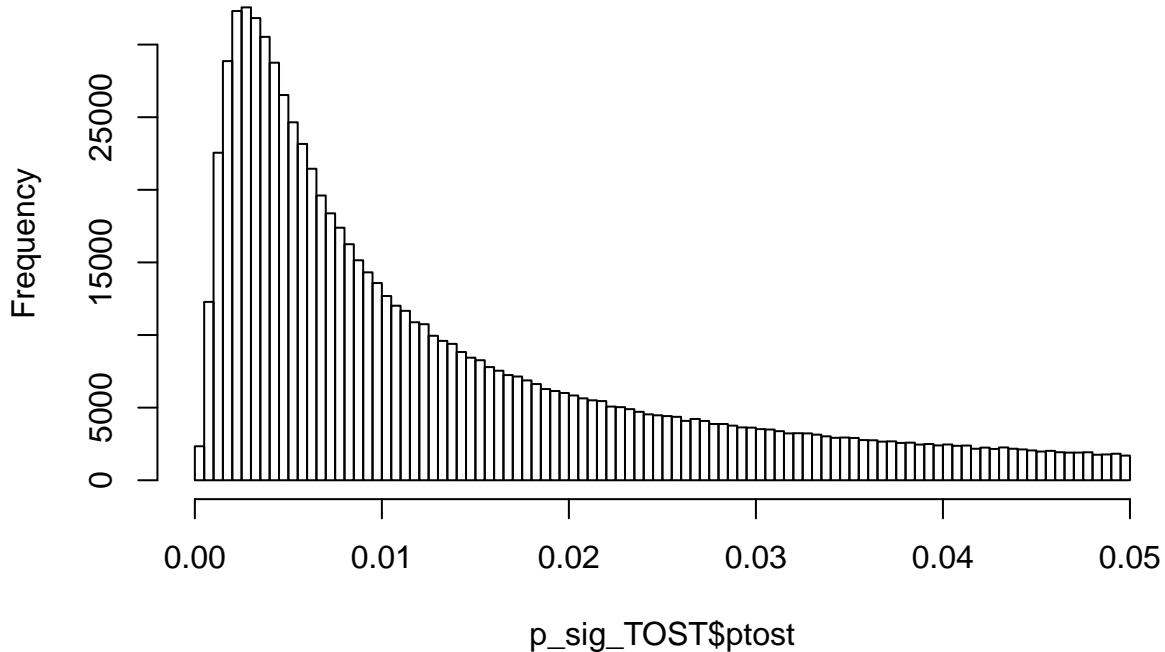
```

```
# Plot the p-values for the NHST t-test, but only those for  
# significant TOT results.  
hist(p_sig_TOST$pttest, breaks = 100)
```



```
# plot p-value distribution for TOST - looks peculiar Dat can  
# only be so far removed from one bound, before it gets  
# closer to the other bound. So p = 0.0000001 often not  
# possible (need to widen bounds for that, or increase N)  
hist(p_sig_TOST$ptost, breaks = 100)
```

## Histogram of p\_sig\_TOST\$ptost



```
# How often is a test significant AND equivalent?  
nrow(p[which(ptost < alpha & pttest < alpha), ])/nSims  
  
## [1] 0.000066  
# plot p-values against each other for TOST and NHST  
plot(ptost, pttest)
```

