Power analysis

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Example

You are working on designing a new cancer drug and want to increase its half life in the body from currend standard of 20 hours (with a std. dev. of 4 hours) for cancer drugs.

You believe your new design can increase the half-life by 2 hours to 22 hours. You have 44 random samples of your new drug for half life.

Determine the power of your study (for $\alpha = 0.05$). If it is lacking power, what can you do to increase its power?

Components of power analysis

- Model (test)
- Test Effect (effect size and variability)
- Sample size (n)
- Test size (significance level, α)
- Power of test $(1 - \beta)$

Hypotheses

- $H_0: \ \mu = 20$
- $H_A: \ \mu = 22$

Effect size 22-20=2

Two-tailed t-test

At what point on H_0 distribution does rejection region start (corresponds to $\alpha/2$)?

T-table for df=43. $t_{critical} value = 2.0166922$

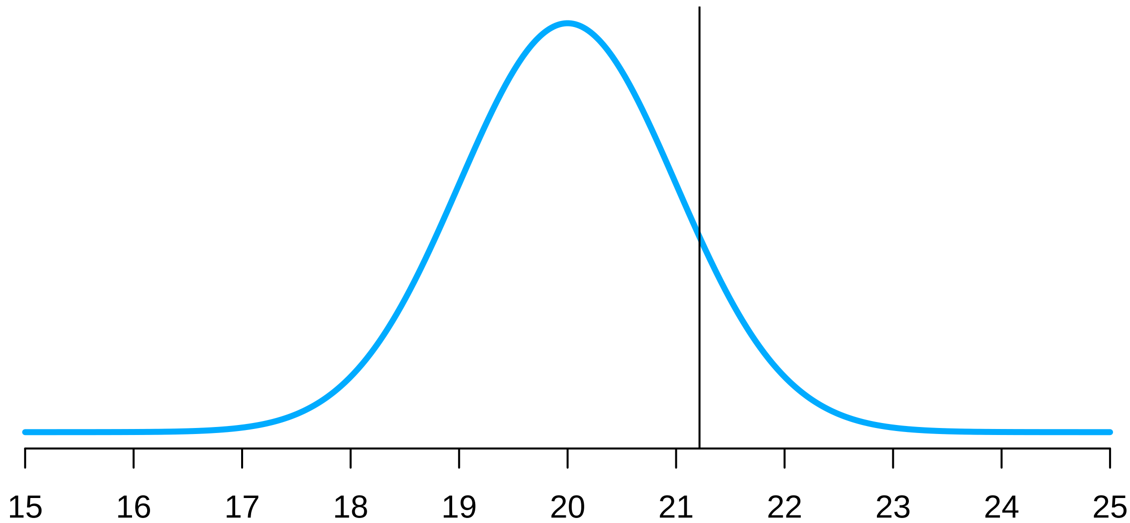
$$t_{stat} = \frac{\hat{x} - \mu}{\frac{s}{\sqrt{n}}}$$

$2.0166922 = \frac{x_{critical} - 20}{4/\sqrt{44}}$

$x_{critical} = 21.2161$

H_0 distribution

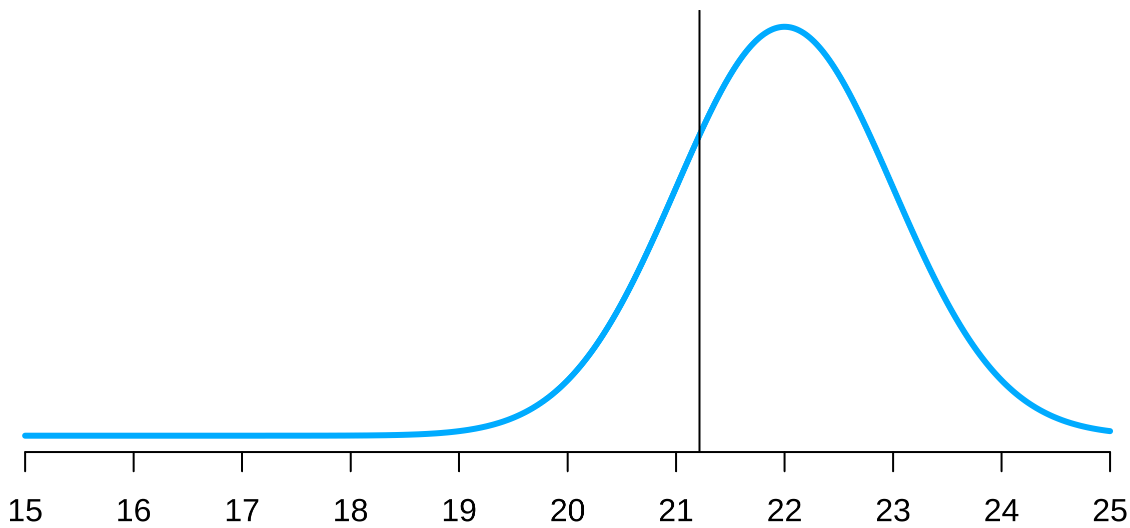
Area to the right corresponds to $\alpha/2$



H_A distribution

Area to the right corresponds to $AUC = \beta$ - probability of a Type II error.

To the right - $1 - \beta$ - power

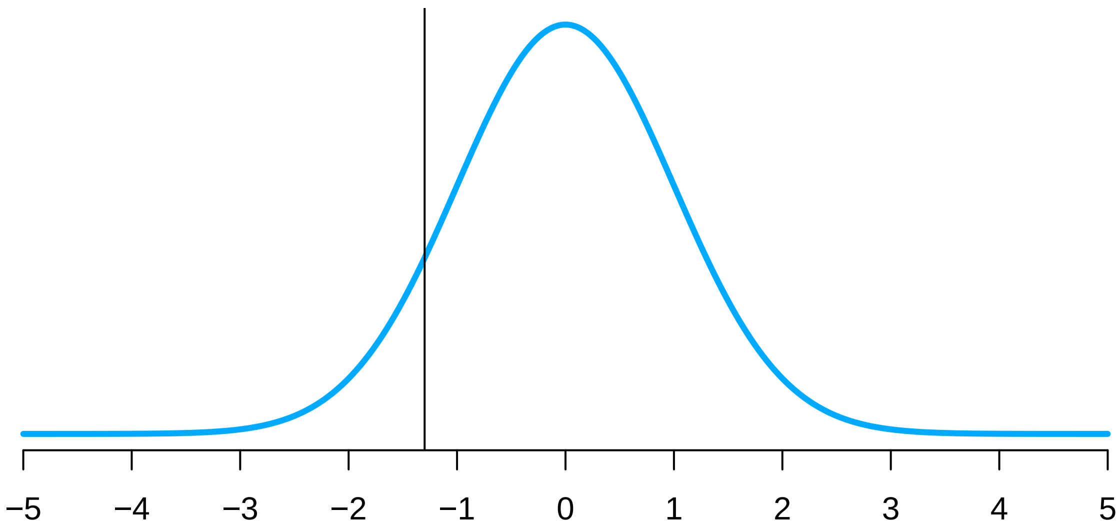


How to find β?

What is the probability of having a value less than $t_{critical}$ (21.2161) in H_A distribution?

$t_\beta = (21.2161 - 22)/(4/\sqrt{44}) = -1.299$

Plot this value on a t-distribution



$\beta = P(t < -1.299) = P(t > 1.299) = 0.096972$ (0.1003 in the video)

$Power = 1 - \beta = 1 - 0.1003 = 0.8997$

Power > 0.8, therefore experimental design is powerful. Should be able to detect effect size.

References

See power analysis in action: "Power analysis example" video https://www.youtube.com/watch?v=fRm2dEWSJrk by Matthew Novak.

- https://www.bu.edu/orccommittees/iacuc/policies-and-guidelines/sample-size-calculations/
- http://www.3rs-reduction.co.uk/html/6___power_and_sample_size.html
- http://www.ats.ucla.edu/stat/seminars/Intro_power/
- http://biostat.mc.vanderbilt.edu/wiki/Main/PowerSampleSize

Online tools

- http://www.gpower.hhu.de/en.html
- http://powerandsamplesize.com/
- http://www.sample-size.net/sample-size-survival-analysis/
- https://www.stat.ubc.ca/~rollin/stats/ssize/n2.html
- http://scotty.genetics.utah.edu/

R packages

- `ssize.fdr` - Sample Size Calculations for Microarray Experiments, https://cran.r-project.org/web/packages/ssize.fdr/index.html
- `ssize` - Estimate Microarray Sample Size, https://bioconductor.org/packages/release/bioc/html/ssize.html

- `sizepower` - Sample Size and Power Calculation in Micorarray Studies, https://bioconductor.org/packages/release/bioc/html/sizepower.html
- `OCplus` - Operating characteristics plus sample size and local fdr for microarray experiments, https://bioconductor.org/packages/release/bioc/html/OCplus.html
- `FDRsampsize` - Compute Sample Size that Meets Requirements for Average Power and FDR, https://cran.r-project.org/web/packages/FDRsampsize/index.html
- `SSPA` - General Sample Size and Power Analysis for Microarray and Next-Generation Sequencing Data, https://bioconductor.org/packages/release/bioc/html/SSPA.html
- `RNASeqPower` - Sample size for RNAseq studies, https://bioconductor.org/packages/release/bioc/html/RNASeqPower.html