

# Power analysis

Mikhail Dozmorov

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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 current 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,  $\alpha$ )
- 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  $df=43$ .  $t_{criticalvalue} = 2.0166922$

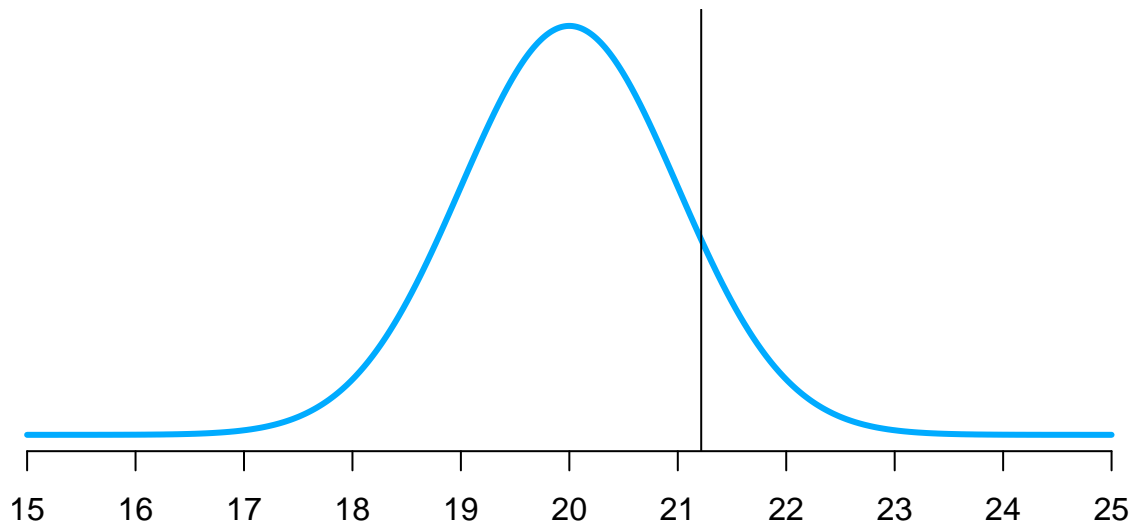
$$t_{stat} = \frac{\hat{x} - \mu}{\frac{s}{\sqrt{n}}}$$

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

$$x_{critical} = 21.2161$$

$H_0$  distribution

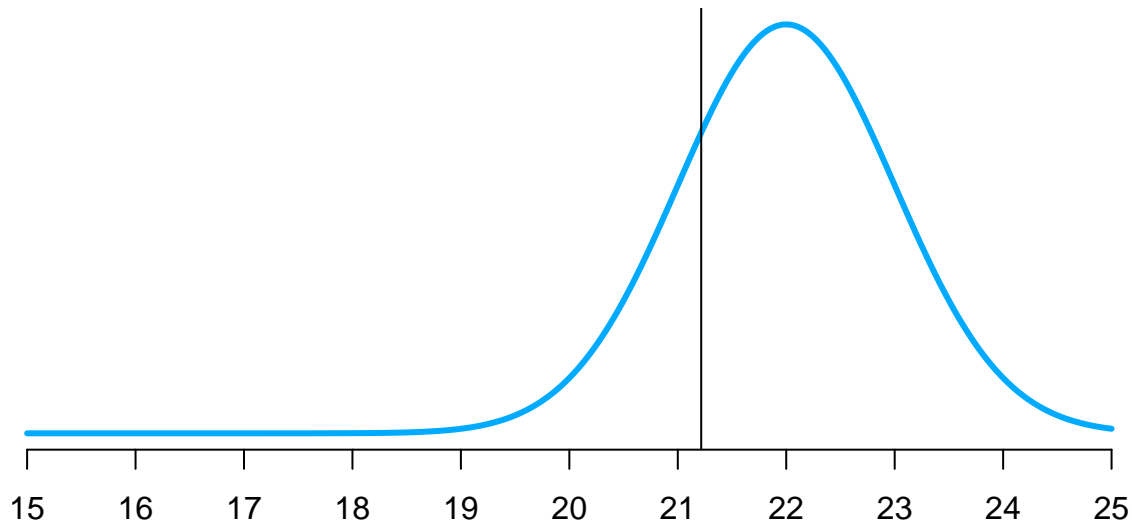
Area to the right corresponds to  $\alpha/2$



$H_A$  distribution

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

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

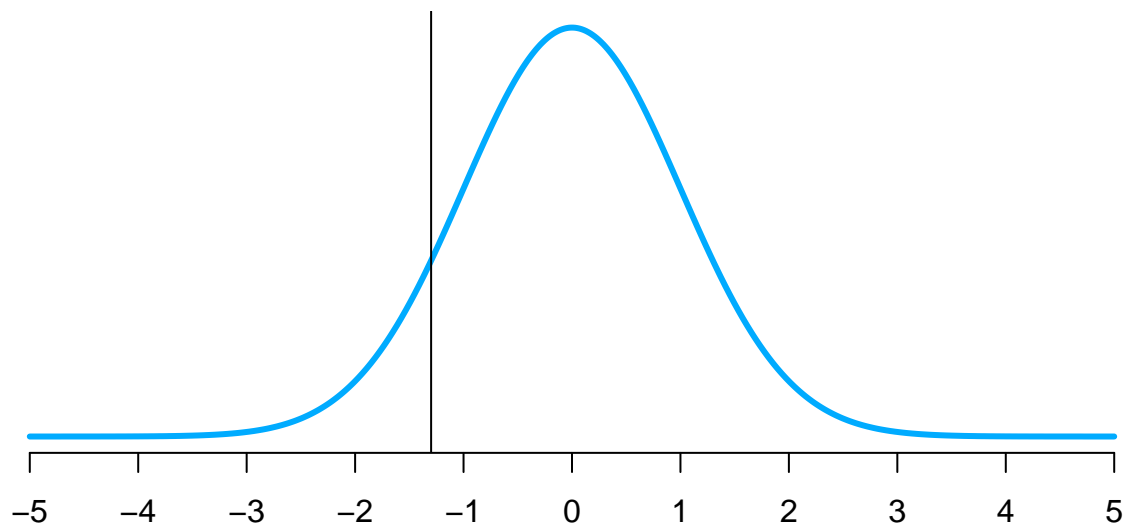


### How to find $\beta$ ?

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



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

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

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.3rs-reduction.co.uk/html/6__power_and_sample_size.html)
- [http://www.ats.ucla.edu/stat/seminars/Intro\\_power/](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>
- **FDRsampsiz**e - Compute Sample Size that Meets Requirements for Average Power and FDR, <https://cran.r-project.org/web/packages/FDRsampsiz/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>