Medical Statistician Presentation

NTNU Interview Case

Artem Shiryaev

2023-11-28

Research Problem

- Klinisk studie på nydiagnostiserte pasienter med myelomatose

Fra tidigare studier kan forvente:

- ARM A: 50% minimal residual disease (MRD)

Klinisk signifikant bedring om:

- ARM B: 70% minimal residual disease (MRD)

Statistical Question

Hvor mange patienter trenger studien vår, med 80% power og signifikansnivå på 5 %?

$$H_0 : p_1 = p_2$$

$$H_1 : p_1 > p_2$$

$p_1 = 0.7, p_2 = 0.5$

	Decision: H0 True	Decision: H0 False
Null Hypothesis	Correct (True Negative)	Type I Error (Reject True H0, α)
Alternative Hypothesis	Type II Error (Fail to reject H0, β)	Correct (True Positive)

Statistical Question

Hvor mange patienter trenger studien vår, med 80% power og signifikansnivå på 5 %?

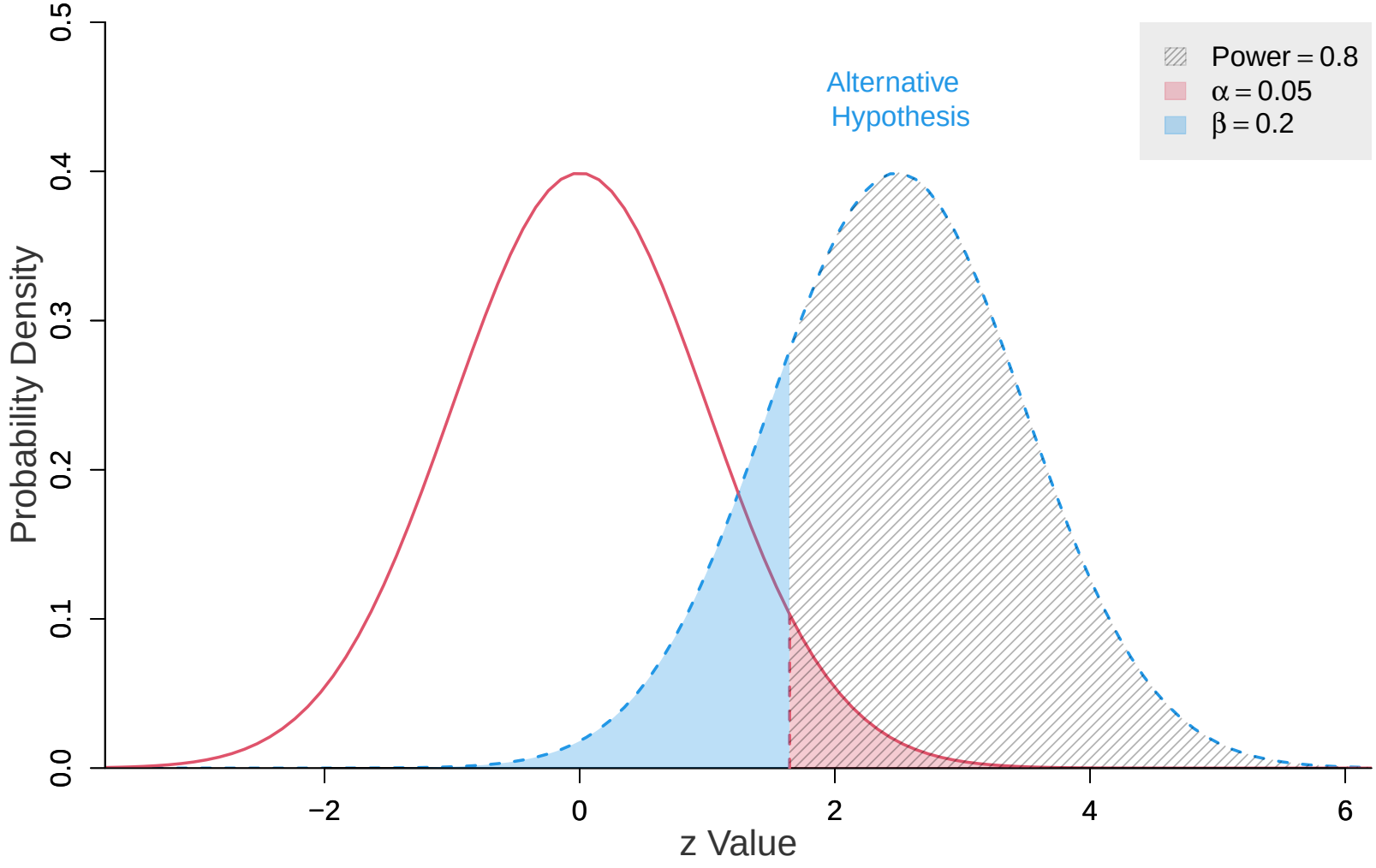
$$H_0 : p_1 = p_2$$

$$H_1 : p_1 > p_2$$

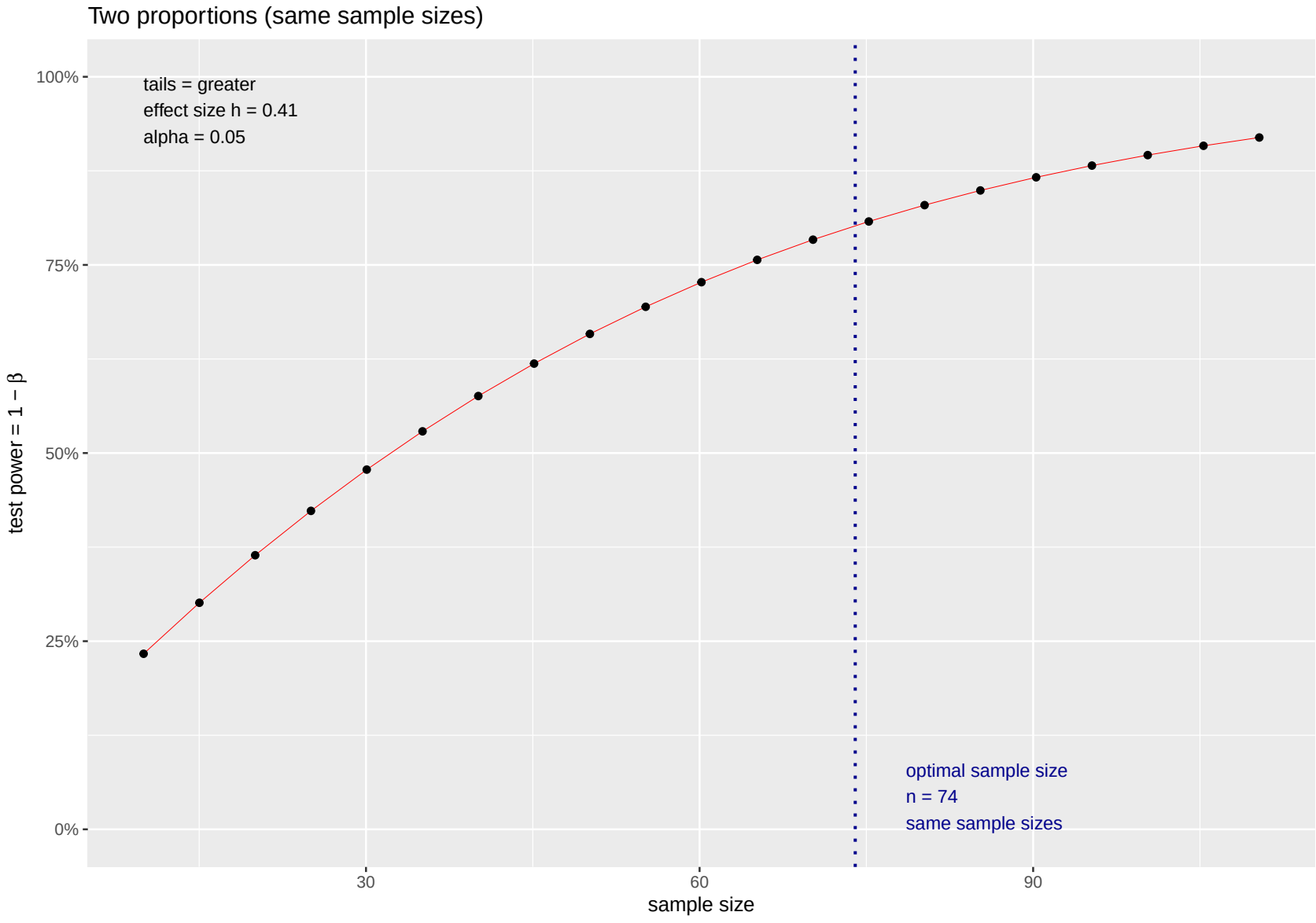
$p_1 = 0.7, p_2 = 0.5$

- Two proportion Z test
- Two sample proportion t-test
- Mann-Whitney U test
- Chi squared test

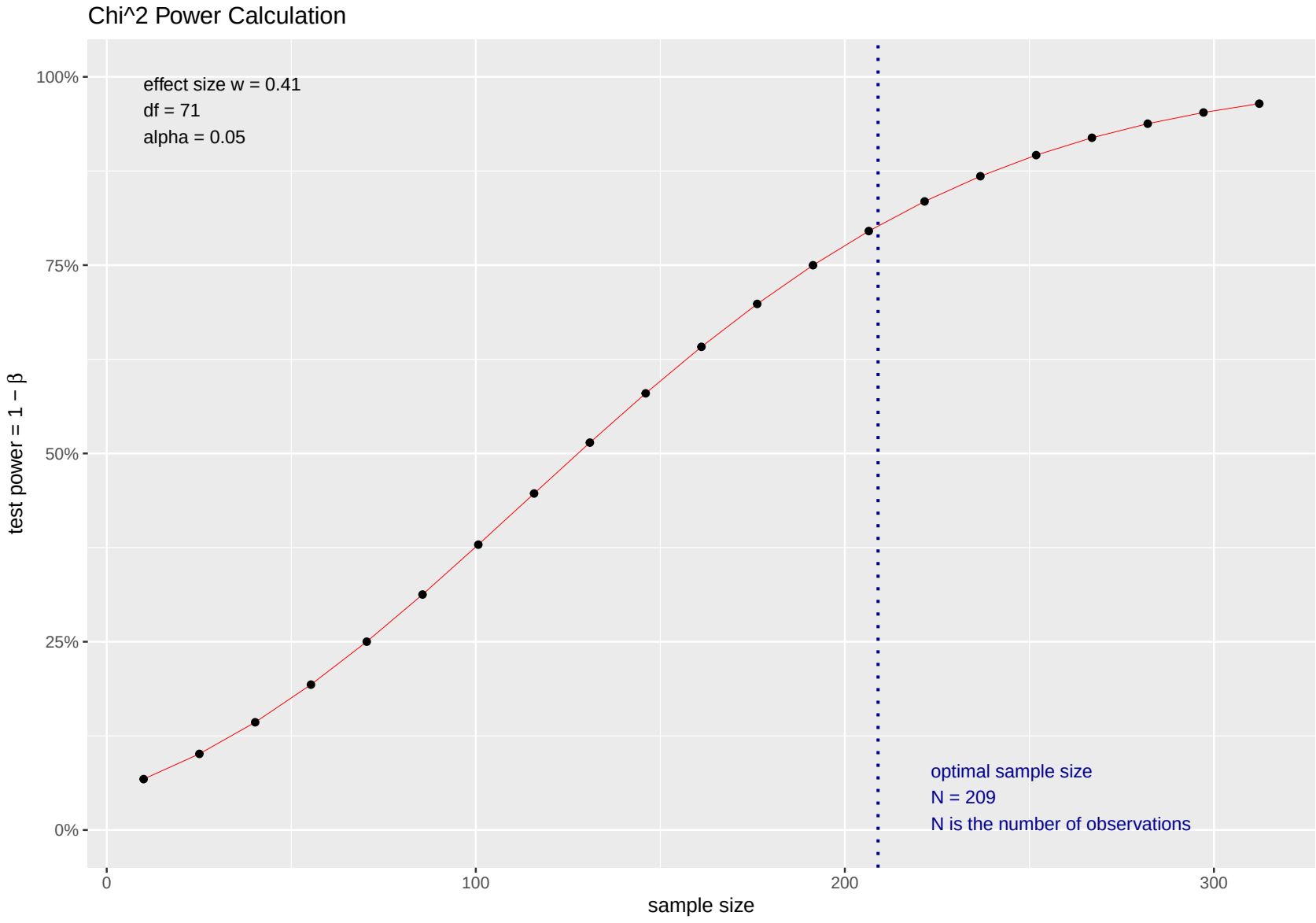
Grafiske resultat Z Test



Grafiske resultat Student t-test



Grafiske resultat Chi^2



Resultat oberoende data (independent data)

Beste fall: total 142 patienter, 71 vardera gruppe
Verste fall: 209

Test	Same	Different	Assumptions
Two Sample Z	71 + 71	-	Normality, iid
Two Sample T	74 + 74	140 + 50	Approx. Normal, iid
Mann-Whitney U	78 + 78	-	Non-parametric, iid, effect size $\approx$ 0.41
Chi^2 ($df = 70$)	209	-	Z scores for df

Resultat beroende data (paired/dependent data)

Beste fall: total 78 patienter, 39 vardera gruppe
Verste fall: 80

Test	Same	Assumptions
Two Sample T	$39 + 39$	Approx. Normal, iid
Wilcoxon signed-rank Test	$40 + 40$	Non-parametric, iid, effect size ≈ 0.41

Analytisk beregning: Z-tests

$$H_0 : p_1 = p_2$$

$$H_1 : p_1 > p_2$$

Formula för two-sample proportion test;

$$Z = \frac{(p_1 - p_2)}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}}$$

Simplifierad to, givet$n_1 = n_2 = n$:

$$n = \frac{(p_1(1-p_1) + p_2(1-p_2))(Z_\alpha + Z_\beta)^2}{(p_1 - p_2)^2}$$

Analytical Calculation: Z-tests

p_1 MRD for ARM A (50%, 0.5).
p_2 MRD for ARM B (70%, 0.7).
Z_α för 5% significance level (1.645).
Z_β för 80% power (0.84).

Analytisk beregning: Z-tests

Substituera värdena in i formula og beregna n:

$$n = \frac{(0.5 \times 0.5 + 0.7 \times 0.3)(1.645 + 0.84)^2}{(0.5 - 0.7)^2}$$

Sedan,

$$n = \frac{(0.25 + 0.21)(2.485)^2}{0.04}$$

$$n = \frac{0.46 \times 6,18}{0.04}$$

$$n = \frac{3.6064}{0.04}$$

$$n \approx 71$$

Analytisk beregning: Student t-test

Börja med forumlan för t-statistics two-sample proportion t-test:

$$t = \frac{(\hat{p}_1 - \hat{p}_2)}{\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}}$$

For n,

$$n = \frac{(t_{\alpha/2,df} + t_\beta)^2 \times (p_1(1-p_1) + p_2(1-p_2))}{(p_1 - p_2)^2}$$

$\hat{p}_1$ og $\hat{p}_2$ er sample proportioner for 'gruppe' 1 og 2, $\hat{p}_1 = 0.5$ (for ARM A),
$\hat{p}_2 = 0.7$ (for ARM B),
Degrees of freedom (df) för t-distribution: $df = 2n - 2$,
$t_{\alpha/2,df}$ and t_β fra t-distribution tables.

Analytisk beregning: Student t-test

$$n = \frac{(1.65 + 0.85)^2 \times (0.5(1 - 0.5) + 0.7(1 - 0.7))}{(0.5 - 0.7)^2}$$

$$n \approx \frac{(2.5)^2 \times (0.25 + 0.21)}{0.04}$$

$$n \approx \frac{(6,25) \times (0.46)}{0.04}$$

$$n \approx \frac{2.875}{0.04}$$

$$n \approx 72$$

R Code

Github link