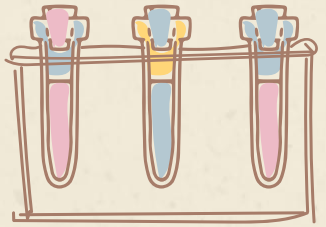
Breast Cancer

Estimation of cancer screening models using deconvolution

Yanting Hu
Mentor: Antonio Olivas



01

Intro: Set up

Facts; Intro; Resuls; Timeline

02

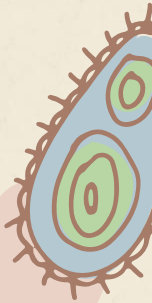
Estimation

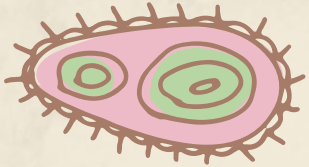
Possible situations and Probability Function

03

Find Maximum Likelihood Function

Find MLE and data application





01

Intro: Set up

Facts; Intro; Tests; Timeline

Relevant Facts:

- In 2022, around 300,000 new breast cancer diagnoses are anticipated
- Breast cancer accounting for nearly one-third of all cancer cases in women
- 1 in 8 women will get breast cancer in their lifetime.
- Breast cancer incidence rates “have been slowly increasing by about 0.5% per year

Intro: What? Why? When? How?

What is Cancer Screening Program?

- Mammography is the most common screening test for breast cancer.

Why screening?

- Accurate diagnosis of a medical condition is often the first step towards it control.
- Early detection of curable tumors that change prognosis

When to start?

- Women within a certain age range, usually starting around 40 or 50.

How frequent?

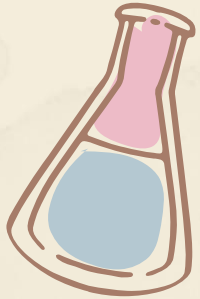
- In order to regularly detect any signs of breast cancer, how often should women do the regular mammogram?

Does the test results perfect? (Sensitivity)

- True Positive/ True Negative/ False Positive/ False Negative

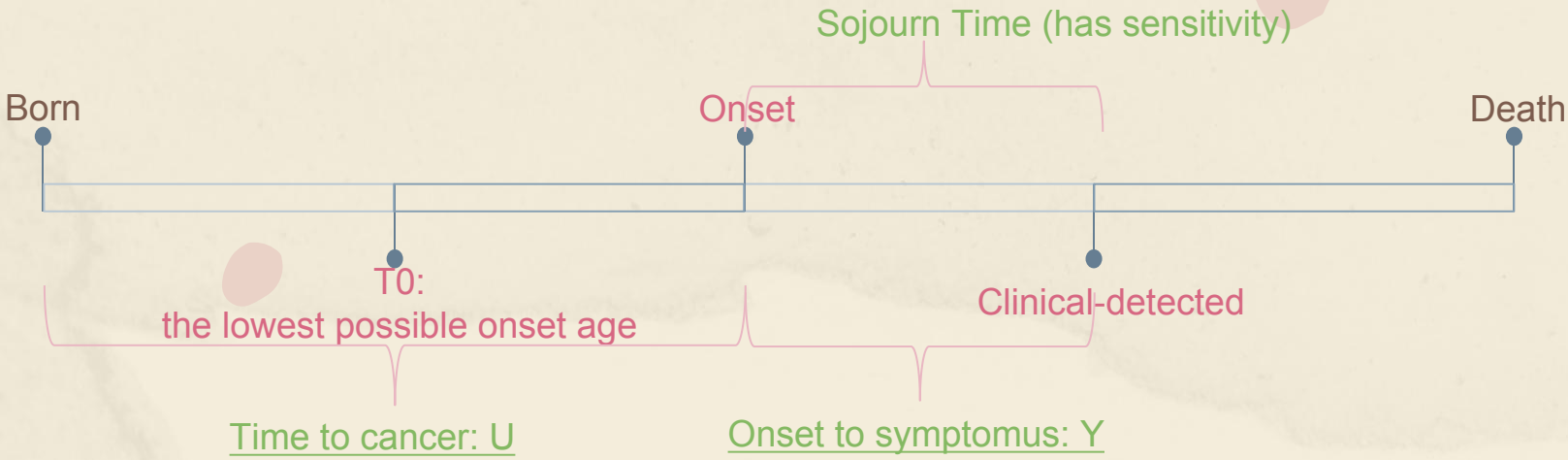
Classification of test results by disease status

	D = 0(H0)	D = 1(H1)
Y = 0	True Negative(Specificity)	False Negative(1-β)
Y = 1	False Positive(α)	True Positive(Sensitivityβ)



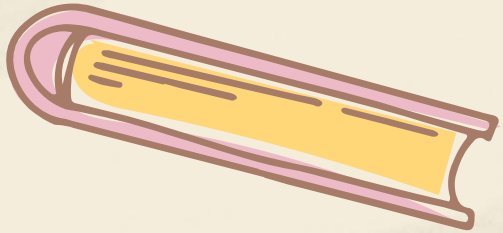
D
- 1: Disease
- 0: non-disease

Y
- 1: Positive for disease
- 0: Negative for disease


Sojourn Time (has sensitivity)
Born
Onset
Death
T0:
the lowest possible onset age
Clinical-detected
Time to cancer: U
Onset to symptomus: Y

02

Estimation

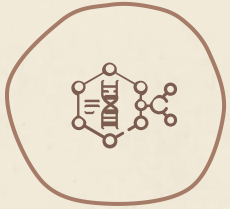


Possible situations and Probability Function

Parameters And Assumptions

Beta(β)

The sensitivity of screening test



Gamma(γ)

U ~ Exp(γ) + 20
PDF:
g(u) = γe^{-γ(u-20)}

Lambda(λ)

Y|U ~ Exp(λ)
PDF:
f(y|u) = λe^{-λy}

t1

t2

has cancer

(Assume specificity = 1 , no false positive, every positive results means cancer)

Test

True Negative:
Cancer-Free

False Negative:
has cancer but not detected

True Negative:
Cancer-Free

False Negative:
Subclinical in t1-t2

True Positive:
has cancer

Negative result

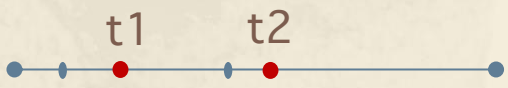
Positive result

[t1,t2)

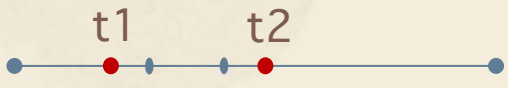
Screen-detected

U<t1, U+Y>t1

Clinical-detected



U<t1, t1<U+Y<t2



t1<U<t2, t1<U+Y<t2

Cancer-Free

1 - screen_detected - clinical_detected

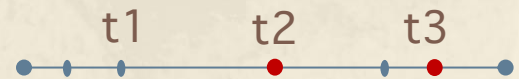
[t2,t3)

Screen-detected

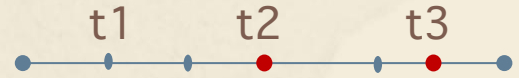
U<t1, U+Y > t2

t1<U<t2, U+Y > t2

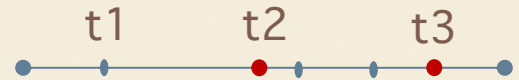
Clinical-detected



U<t1, t2<U+Y<t3



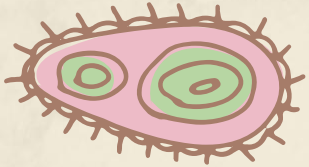
t1<U<t2,t2<U+Y<t3



U>t2, t2<U+Y<t3

Cancer-Free

1 - screen_detected - clinical_detected



03 Find Maximum Likelihood Function

Find MLE and data application

Create A Data Frame

Name <chr>	Screen_detected <dbl>	Clinical_detected <dbl>	Cancer_free <dbl>
interval_1	142	15	19554
interval_2	66	10	17593
interval_3	43	9	17295
interval_4	54	9	17130
interval_5	28	5	9843

5 rows

Research data: record the number of cases of screen-detected, clinical-detected, and cancer-free from women who attended all screening rounds up to and including the current round.

PS:
interval1:[55,56)
interval2:[56,57)
...

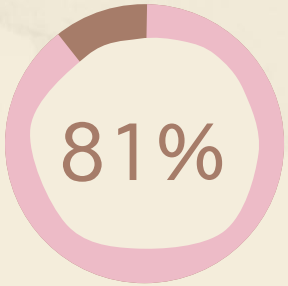
Use R to find The Maximum Likelihood Estimator of β, γ,λ respectively

```r
result1 <- optim(par = c(0.1, 0.001, 0.0021),
function(m)loglikelihood(m[1],m[2],m[3]), method = "Nelder-Mead")

# Extract the optimized parameter and objective value
result1$par
```

```
[1] 0.80675565 0.00309542 0.30285784
```

Interpretation of Results



Beta(β)

Sensitivity: The mammogram will detect cancer in 81% women with cancer.

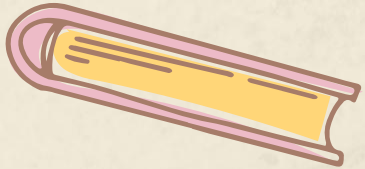
Gamma(γ)

6% of women will have onset of cancer by age 40.

Lambda(λ)

On average, the sojourn time is 3.33, that means the interval of doing mammogram should be shorter than 3.33 years

Limitations/Extensions

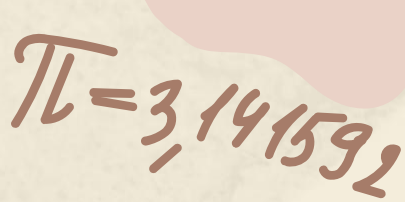


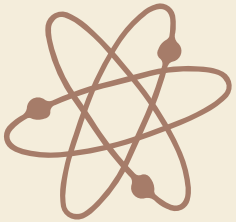
- Assume Exponential Distribution
- Applied to More Complex Model That Can Fit The Data Better
- We do not provide Confidence Interval for parameters, but we can use Bootstrapping Sample to build a Confidence Interval
- We need to assess the performance of estimators under correct model specification.

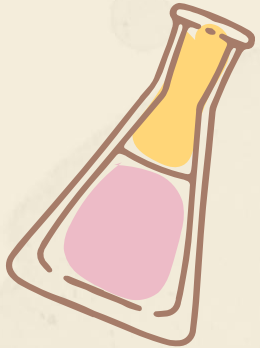
Thanks!

Special Thanks to Antonio Olivas And DRP

CREDITS: This presentation template was created by Slidesgo, including icons by Flaticon, and infographics & images by Freepik







Reference

Breast Cancer 101 — Keep A Breast Foundation. (n.d.). Keep a Breast Foundation. https://www.keep-a-breast.org/breast-cancer-101?gclid=EAIaIQobChMIqp-jg5uJ_wIVyCatBh2LsQxyEAAYASAAEgIjNfD_BwE

Breast cancer. (2023, April 13). Understanding Cancer Together. https://www.understandcancertogether.com/understand-cancer/types-of-cancer/breastcancer/?utm_source=google&utm_medium=cpc&utm_campaign=UCT_Breast_UNBD_NA_EDUC_MULTI_TEXT_NA&utm_content=UCT+-+Breast+-+Exact&utm_term=what+is+breast+cancer&utm_kxconfid=ut5vrhsig&utm_brand=uctconsumerunbranded&gclid=EAIaIQobChMI9fyswqKJ_wIVagCtBh1m-QelEAAYAiAAEgLFr_D_BwE&gclsrc=aw.ds

Anthony B Miller, Cornelia J Baines, Teresa To, and Claus Wall. Canadian national breast screening study: 1. breast cancer detection and death rates among women aged 40 to 49 years.
CMAJ: Canadian Medical Association Journal, 147(10):1459, 1992.