

Module 2

Part 1 - Probability and Diagnostic Tests

R Lab 1 - COVID-19 Tests

Part 2 - Probability Distributions

R Lab 2 - Simulations

Alvaro Köhn-Luque

Oslo Centre for Biostatistics and Epidemiology (OCBE), UiO and OUS

a.k.luque@medisin.uio.no

MF9130E - Introductory Course in Statistics

Spring 2023

Week 1	Monday (24-04)	Tuesday (25-04)	Wednesday (26-04)	Thursday (27-04)	Friday (28-04)
Location	DM Lille auditorium	DM Auditorium 13	DM Store auditorium	DM Runde auditor.	DM Store auditorium
08:30-11:45		C and M SEM*	A SEM*	C SEM*	C SEM*
12:45-16:00	M FOR*	A FOR*	V FOR*	V FOR*	

Week 2	Monday (08-05)	Tuesday (09-05)	Wednesday (10-05)	Thursday (11-05)	Friday (12-05)
Location	DM Lille auditorium	Helga Engs hus Aud 3	DM Auditorium 13	DM Auditorium 13	
08:30-10:00	C FOR	J FOR	M FOR	M FOR	
10:15-11:45	C SEM	J FOR	M and C SEM	M and C SEM	
12:45-14:15	V FOR	M FOR	M FOR	M FOR	
14:30-16:00	V and C SEM	M and C SEM	M and C SEM	M SEM	

Topic
Course introduction; Data and descriptive statistics
Foundations: probability, Bayes law and diagnostic tests, statistical distributions (normal and binomial distribution)
Statistical inference: hypothesis testing and confidence intervals, t-tests, tests for contingency tables
Transformations, non-parametric methods
Sample size and statistical power
Study designs: epidemiological designs and concepts, principles of clinical trials
Regressions: simple and multiple regression, confounding and interactions, linear and logistic regression
Survival analysis; Course summary

Lecturer
M = Manuela Zucknick
A = Alvaro Köhn-Luque
V = Valeria Vitelli
J = Jo S Stenhjem
C = Chi Zhang

Lecture or Lab
FOR = Lecture (classical format)
SEM = Lab (classical format)
FOR* = Lecture (flipped classroom setup)
SEM* = Lab (flipped classroom setup)

Afternoon session (DM Auditorium 13)

Tuesday 25, 12:45 - 16:00

- 12:45 - 13:00 **Introduction** to probability and diagnostic testing
- 13:00 - 14:30 **Self-study** of part 1 with Q&A
- 14:30 - 15:00 **Break**
- 15:00 - 15:15 **Introduction to COVID-19 testing**
- 15:15 - 15:45 **Discussion in groups**
- 15:45 - 16:00 **Summary** of this session

Morning session (DM Store Auditorium)

Wednesday 26, 8:30 - 11:45

- 8:30 - 9:15 **R Lab 1: COVID-19 Tests**
- 9:15 - 9:30 **Introduction** to probability distributions
- 9:30 - 9:45 **Break**
- 9:45 - 10:45 **Self-study** of of part 2 with Q&A
- 10:30 - 10:45 **Break**
- 10:45 - 11:30 **R Lab 2: Simulations**
- 11:30 - 11:45 **Summary** of this session

Course material

[</> Code](#)

On this page you'll find a list of material used in this course.

For the exercises and lab notes we use during the lab sessions, please check the [R Lab and Code](#).

Week 1

Time	Topic	Lecture notes	Lab	Other
April 24 PM	Course introduction	Slides		
	Descriptive statistics	Slides , K&S chapter 2-4, Aalen chapter 1-2		Paper 1 , Paper 2 , Paper 3
April 25 AM	Introduction to R and Rstudio	Slides	Intro to RStudio , Intro to R	
	Lab session	Slides	Descriptive statistics (EDA I)	
April 25 PM	Probability, diagnostic tests	Probability, Diagnostic tests		
	Statistical distributions	Distributions		
April 26 AM	Lab session		COVID-19 tests , Simulations	
April 26	Statistical inference: tests and			

Key concepts to learn today

Lecture notes: Probability

- Probability and basic probability calculations
- Conditional probability and stochastic independence
- Bayes law and Bayesian statistics

Lecture notes: Diagnostic Tests

- Sensitivity and Specificity
- Calculation of Positive Predictive Value (PPV) and Negative Predictive Value (NPV) using Bayes law

[nature](#) > [nature reviews genetics](#) > [review articles](#) > [article](#)

Review Article | [Published: 04 May 2021](#)

Testing at scale during the COVID-19 pandemic

[Tim R. Mercer](#)  & [Marc Salit](#)

[Nature Reviews Genetics](#) **22**, 415–426 (2021) | [Cite this article](#)

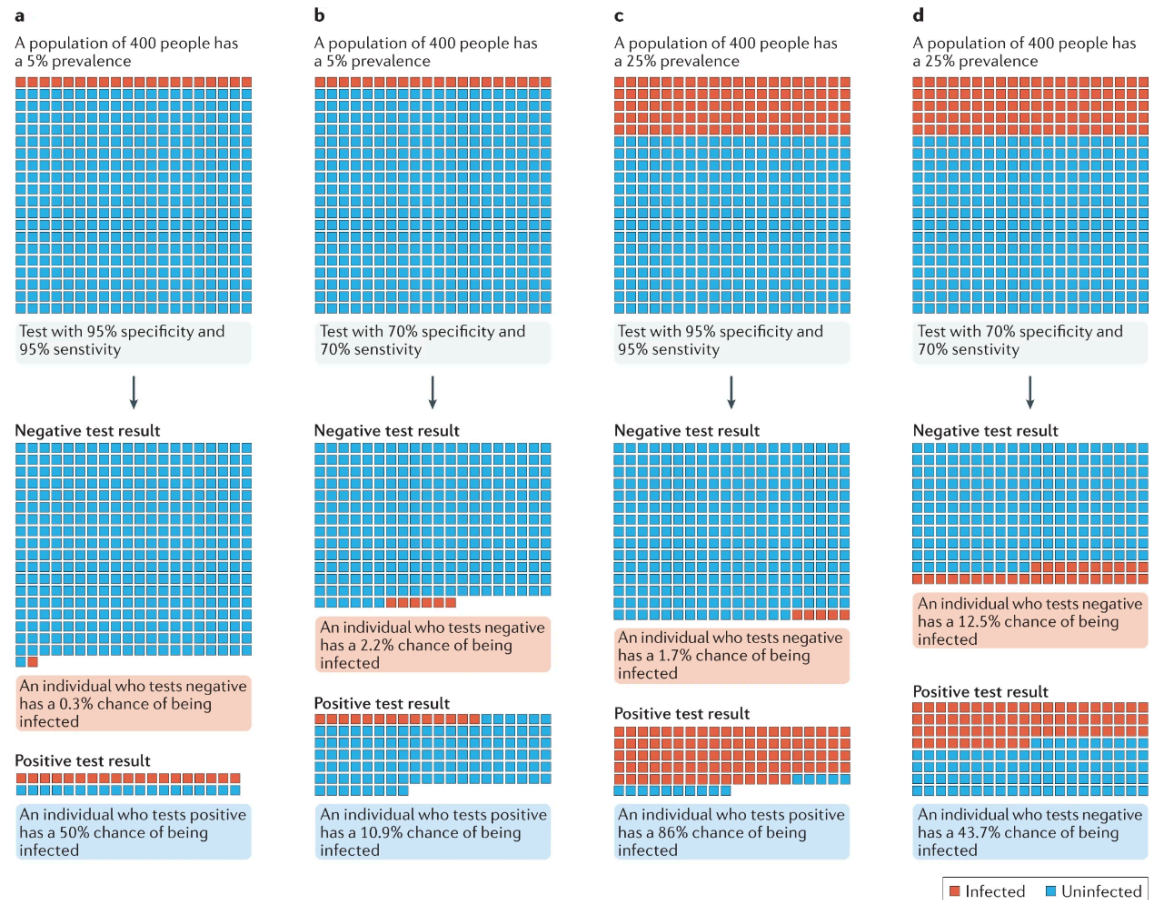
72k Accesses | **147** Citations | **859** Altmetric | [Metrics](#)

Topics for COVID-19 Tests Discussion

We will focus on Figure 2 from:
T.R. Mercer and M. Salit, [Testing at scale during the COVID-19 pandemic](#), Nature Reviews Genetics 22, 415-426 (2021)

Fig. 2: How test sensitivity, specificity and disease prevalence influence the interpretation of test results.

From: [Testing at scale during the COVID-19 pandemic](#)



- Identify all the probabilities in this figure.
- How are the number of negative and positive tests computed in each case?
- Based on these probabilities, would you ever recommend population-scale testing?
- Would you instead recommend testing to specific groups? Which ones?

Summary

- **Probability** of an event is the **frequency** that the event occurs in a large number of trials.
- A probability is always a **value between 0 and 1**. There are basic rules to do **probability calculations** (complement, additive and multiplicative rule).
- A **conditional probability $P(A|B)$** is the probability of A given that B has occur.
- Events A and B are **independent** if $P(A|B) = P(A)$, then $P(A \cap B) = P(A)P(B)$
- **Bayes law:** $P(B|A) = P(A|B) * P(B) / P(A)$
- Use conditional probabilities and Bayes law to understand sensitivity, specificity, PPV and NPV.
- Role of **prevalence** in diagnostic tests results.