

# Name of course: Bayesian Hierarchical Modelling

**ECTS credits: 3**

**Course parameters:**

*Language:* English

*Level of course:* PhD course

*Time of year:* Spring 2025

*No. of contact hours/hours in total incl. preparation, assignment or the like:* 35/80

*Capacity limits:* 16 participants

**Objectives of the course:** The PhD students will be introduced to Bayesian hierarchical modelling, which are becoming increasingly popular for fitting ecological, environmental, and human disease models to temporal and spatial data. The aim of the course is to introduce the students to i) the applied use of likelihood functions and Bayesian statistics, ii) setting up advanced hierarchical statistical models with latent variables, iii) applying advanced statistical models, and iv) making quantitative predictions with a known degree of uncertainty.

**Learning outcomes and competences:**

At the end of the course, the student **should be able to:**

- assess the possible value of using advanced hierarchical statistical methods in the students own work
- critically evaluate scientific literature using advanced statistical models

**Compulsory program:** preparation, active participation, assignment

**Course contents:**

- Introduction to likelihood functions and Bayesian statistics
- Hierarchical models with latent variables
- Fitting models to data using Bayesian methods
- Model prediction

**Prerequisites:** Introductory probability and statistics courses

**Name of lecturers:** Christian Damgaard and Peter Borgen Sørensen

**Type of course/teaching methods:** Seminars and exercises using R

**Literature:** Before the course starts the students are expected to have read chapters 1, 3-7 in the electronic book: <https://bayesball.github.io/BOOK/probability-a-measurement-of-uncertainty.html>, and be familiar with the statistical software R (e.g. watch the video Getting started with R and R studio (14 minutes) by HowToR on you Tube).

**Software:** R, RStudio, RTMB

We will use the software RTMB (<https://cran.r-project.org/web/packages/RTMB/vignettes/RTMB-introduction.html>). It is not assumed that you have any skills in this package.

**Course homepage:** None

**Course assessment:** Personalized reports (approximately 10-30 pages, corresponding to a workload of 20 hours outside, and in the week after the end of the scheduled classes) must be completed and submitted for approval (pass/fail).

**Provider:** Department of Ecoscience, Aarhus University

**Special comments on this course:** All expenses for accommodation and travel are paid by the student.

**Time:** 7/4-11/4 2025

**Place:** Department of Ecoscience, Aarhus University, Denmark

**Registration:** Deadline for registration is 1/4 2025 (first come, first served).

For registration: Christian Damgaard, e-mail: [cf@ecos.au.dk](mailto:cf@ecos.au.dk)

### Course Program

The topics of the 5 days are as detailed below, and each topic starts with a lecture followed by computer exercises in R which are carried out in teams of two-three participants. Each participant must produce a personalized report of the exercises. During the course, the participants should be prepared to work outside the scheduled classes to complete the computer exercises.

#### Day 1

10:00 – 10:15	Welcome, Introduction to Course
10:00 – 12:00	Lecture 1: Probability theory – the logic of science
12:00 – 13:00	Lunch
13:00 – 15:00	Lecture 2: Probability distributions and likelihood functions, exercises in R
15:00 – 15:15	Break
15:15 – 16:00	Short plenum presentation of the student's own data and methods.

#### Day 2

08:30 – 10:00	Lecture 3: Bayesian statistics and MCMC, exercises in R
10:00 – 10:15	Break
10:15 – 12:00	Lecture 4: Laplace's approximation - RTMB
12:00 – 13:00	Lunch
13:00 – 15:00	Exercises in RTMB
15:00 – 15:15	Break
15:15 – 16:00	Exercises in RTMB

#### Day 3

08:30 – 10:00	Lecture 5: Structural equation modelling
10:00 – 10:15	Break
10:15 – 12:00	Exercises in RTMB
12:00 – 13:00	Lunch
13:00 – 15:00	Exercises in RTMB
15:00 – 15:15	Break
15:15 – 16:00	Exercises in RTMB

#### Day 4

08:30 – 10:00	Lecture 6: Prediction and uncertainties
10:00 – 10:15	Break
10:15 – 12:00	Exercises in RTMB
12:00 – 13:00	Lunch
13:00 – 15:00	Exercises in RTMB
15:00 – 15:15	Break
15:15 – 16:00	Exercises in RTMB

#### Day 5

08:30 – 10:00	Exercises in RTMB
10:00 – 10:15	Break
10:15 – 12:00	Evaluation in plenum to identify relevant methods for students' own data.
12:00 – 13:00	Lunch
13:00 – 14:00	Evaluation and departure

Within two weeks	Submission of final report by e-mail to Christian Damgaard
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If you have any questions, please contact Christian Damgaard or Peter Borgen Sørensen

Til annoncering på webside – til boks i øverste højre hjørne:

### PLEASE NOTE

Deadline for registration is 1/4 2025 (first come, first served).

If you have any questions, Christian Damgaard, e-mail: [cf@ecos.au.dk](mailto:cf@ecos.au.dk)