**Course Description: Bayesian data analysis and multilevel modeling**

4 hp

<table>
<thead>
<tr>
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</thead>
<tbody>
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**Language:** English.

**Course level:** Doctoral level.

**Eligibility criteria:** Accepted for studies at doctoral level within social sciences including public health.

**Main field of study:** Psychology.

**Host department:** Department of Psychology, Stockholm University.

Sign up: [http://www.psychology.su.se/utbildning/alla-utbildningar/forskarniv%C3%A5/studiehandbok-forskarniv%C3%A5/anm%C3%A4lan-till-kurser-inom-forskarutbildningen-1.30731](http://www.psychology.su.se/utbildning/alla-utbildningar/forskarniv%C3%A5/studiehandbok-forskarniv%C3%A5/anm%C3%A4lan-till-kurser-inom-forskarutbildningen-1.30731)

Note that the number of participants will be limited and registration is on a first-come, first-served basis.

**Bayesian data analysis and multilevel modeling**

The course will start with a general seminar to discuss the benefits of Bayesian approaches to data analysis for Psychology scholars.

At the beginning, the course will cover the basics of probability from scratch in order to introduce the basics of Bayesian data analysis. The second lecture will present the main Bayesian approaches to Bayesian data analysis and Bayesian hypothesis testing.

Besides the theoretical aspects, the course will offer actual programming in R to show how to generate priors, likelihood and posteriors on the basis of practical examples.

Then, we will narrow down our focus on multilevel models (MLMs) because these are more robust to unequal sample sizes, missing data, and extreme cases, as estimation of individual level and group level parameters inform each other in an updating process (e.g. Gelman & Hill, 2007). Also, MLM can be nicely combined with Bayesian approaches (McElreath, 2016).

To illustrate the advantage of MLM, categorical data are often analyzed as accuracy rates (in percent), but Jaeger (2008) has shown that this approach can lead to spurious results, as linear models such ANOVAs rest on assumptions that are not tenable when dealing with categorical data. These issues are avoided in Generalized Linear Mixed Models (AKA Generalized Multilevel Models, GMLMs) for binomially distributed outcome. GMLMs combine the advantages of ordinary logit models with the ability to account for random subject and item effects at once. Also, the use of GMLMs provides a much more flexible approach that allows to model continuous variables on a trial-by-trial basis. Therefore, the second week of the course introduces multilevel models (MLMs) more broadly and teaches how to implement them in the popular R package lme4. Last, we
will show how to adopt a Bayesian approach in multilevel modeling and model comparison using the Bayesian Regression Models with Stan (brms) package. Previous knowledge of the R statistical programming language is preferred, but we will provide some extra introductory courses in the afternoon (1PM – 3PM each day), to allow everyone to follow to use the code provided in the course.

**Expected learning outcomes**
After the course, students will be able to compute Bayes Factors and to perform a Bayesian multilevel model analysis on their own datasets.

**Examination**
One week after the end of the course participants will have to submit a final, written assignment that will require the analysis of real or simulated data, which will be then reported as a results paragraph. Participants need to submit a brief paper (max 3 pages) where they will briefly state their hypotheses, report the results and interpret them. The submission should be accompanied by commented R code along with the dataset used in their analysis. The submission will be assigned to an Editor (one of the three teachers) and two Reviewers (two other students). The examined student should then provide a rebuttal letter (max 1 page) in response to the Editor and Reviewers’ comments. Students will be graded for both their submissions and their feedback as Reviewers as follows. Thirty-two points system (pass = 16). Students will be graded for: their original paper (8 points); R code (8 points); rebuttal letter (8 points); reviewer activity (8 points).

**Timeline**: the submission is due by June the 15\(^{th}\); feedback from the reviewers will be sent back by June the 22\(^{nd}\); a rebuttal letter will be sent by June the 29\(^{th}\).

**Grade and grade criteria**
The course is graded on a pass/fail basis: Pass: For a passing grade, the doctoral student has completed the examination requirements and thereby shown that the expected learning outcomes are achieved.
Fail: The examination task has been solved insufficiently, in such a way that the expected learning outcomes are not met.

**Dates**: the course will occur on week 23 of the year 2018

**Language**: English

**Reading lists**

**Mandatory:**
Mandatory readings


Preliminary schema

<table>
<thead>
<tr>
<th>Day</th>
<th>Weekday</th>
<th>Place</th>
<th>Hours</th>
<th>Topic</th>
<th>Teacher</th>
<th>Lecture type</th>
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<tbody>
<tr>
<td>180604</td>
<td>Mon</td>
<td>U15</td>
<td>9 - 12</td>
<td>Probability, Bayes’ Theorem and Bayesian approaches</td>
<td>MTL</td>
<td>Lecture</td>
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<tr>
<td>180604</td>
<td>Mon</td>
<td>GEL</td>
<td>13 - 15</td>
<td>Workshop in R</td>
<td>MZ</td>
<td>Seminar</td>
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<tr>
<td>180605</td>
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<td>U15</td>
<td>9 - 12</td>
<td>Monte-Carlo-Markov Chain and Information criteria.</td>
<td>MTL</td>
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<tr>
<td>180605</td>
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<td>Workshop in R</td>
<td>MZ</td>
<td>Seminar</td>
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<tr>
<td>180607</td>
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<td>Multilevel linear modeling</td>
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<tr>
<td>180608</td>
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<td>Bayesian Multilevel linear modeling</td>
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<tr>
<td>180608</td>
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