# Manual Advanced Simulation for Health Economic Analysis

# ASH

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## Course description

In many commercial software environments available for discrete event simulation (DES) the modeler is not in full control, and the environments may impose certain limitations on DES development, analysis, and use. Therefore, the interest in developing DES models in suitable free programming environments, such as R, is rapidly increasing. Making use of special-purpose R packages, such as Simmer, developing DES models from scratch and performing any number of advanced (statistical) analyses with these models becomes straightforward and rewarding.

This course is aimed at developing advanced discrete event simulation models in R to accurately reflect processes and events at the level of individuals (for example, citizens, patients, professionals etc) based on empirical data. Models are developed within a health economic case study, in which the impact of health innovations on health outcomes and costs needs to be quantified. However, the skills learned and experienced obtained from this course are directly generalizable to many other quantitative research fields.

## Course learning goals

After following this course the student is able to

1. Develop their own advanced a discrete event simulation model in R using available empirical data to assess the expected impact of health care innovations on health outcomes and healthcare costs;

2. Interpret the results obtained from a patient-level discrete event simulation model in a health and economic context;

3. Understand the value and use of probability distributions, methods for uncertainty analysis, and metamodeling approaches in the context of discrete event simulation modeling.

## Course materials

All required materials will be made available through Canvas.

## **Course schedule** (always check CANVAS for schedule/location updates)

| # | Topic | Description | Hours | Week | Date |
|---|---|---|---|---|---|
| 1 | Intro | Introduction to health economics and HTA (HC-1) | HC (2) | 1 | 3/2 |
| | | Self-study: read introductory papers | Self (4) | 1 | |
| 2 | Intro | Discussion of background materials on HTA and questions (WC 0.0) | WC (1) | 1 | 5/2 |
| | | Self-study: Tutorial part 1: online materials & exercises for R | Self (8) | 1 | |
| 3 | Using R | Tutorial part 1: Introduction to R (WC 0.1) | WC (2) | 2 | 8/2 |
| 4 | Modeling aspects | Concepts of health economic modelling (HC-2) | HC (2) | 2 | 10/2 |
| | | Self-study: read background papers | Self (4) | 2 | |
| | | Self-study: tutorial part 2: online materials & exercises Simmer | Self (8) | 2 | |
| 5 | Using Simmer | Tutorial part 2: Introduction to DES in R (Simmer) (WC 0.2) | WC (2) | 2 | 11/2 |
| 6 | Modeling aspects | Using and fitting empirical distributions in R (HC-3) | HC (2) | 3 | 16/2 |
| | | Self-study: tutorial part 3: building DES for lung cancer | Self (4) | 3 | |
| 7 | First DES model | Tutorial part 3: Building DES model for lung cancer (WC 0.3) | WC (2) | 3 | 17/2 |
| | | Self-study: tutorial part 3: building DES for lung cancer | Self (4) | 3 | |
| 8 | First DES model | Tutorial part 3: Building DES model for lung cancer (WC 0.4) | WC (2) | 3 | 19/2 |
| | First DES model | **DEADLINE SUBMISSION Tutorial part 3:Lung cancer model**<br>• Submit R model code | | 4 | **2/3 (23.59)** |
| 9 | Modeling aspects | Uncertainty, sensitivity, and value of information analysis (HC-4) | HC (2) | 4 | 4/3 |
| | | Self-study: starting on the main course assignment | Self (8) | 4 | |
| 10 | Assignment | General feedback on Tutorial part 3: Lung cancer DES model<br>Assignment part 1: DES model (WC-1.1) | WC (2) | 4 | 5/3 |
| | | Self-study: extending your DES model | Self (8) | 5 | |
| | First DES model | Tailored feedback on Tutorial part 3: Lung cancer DES model (per email) | | 5 | 9/3 |
| 11 | Assignment | Assignment part 1: DES model (WC-1.2) | WC (2) | 5 | 10/3 |
| | | Self-study: extending your DES model | Self (6) | 5 | |
| | | **DEADLINE SUBMISSION Assignment part 1 DES model**<br>• Submit R model code | | | **16/3 (23.59)** |
| 12 | Assignment | Assignment part 2: DES model (WC-2.1) | WC (2) | 6 | 17/3 |
| | | Self-study: extending your DES model | Self (10) | 6 | |
| 13 | Modeling aspects | Advanced modeling topics (HC-5) | HC (2) | 6 | 18/3 |
| | | Self-study: extending your DES model | Self (10) | 7 | |
| 14 | Assignment | Assignment part 2: DES model (WC-2.2) | WC (2) | 7 | 23/3 |
| | | **DEADLINE SUBMISSION Assignment part 1+2 DES model INCLUDING SIMULATION RESULTS:**<br>• Submit R model code + simulation results + interpretation | | 7 | **28/3 (23/59)** |
| 15 | Assignment | Feedback session (FB1): checking the DES model of one other group, providing written feedback<br>***Deadline submission at end of practical hour 2!***<br>Practial hour 3: Course round-up / Q&A / Feedback | WC (3) | 8 | **30/3 (18.00)** |
| | Finalizing assignment | **DEADLINE SUBMISSION FINAL REFLECTION REPORT**<br>• Submit report (Word or PDF document) | | 9 | **6/4 (23/59)** |
| 16 | Assignment | Feedback session on grading of final reports (on demand session) | WC (2) | 10 | 13/4 |

## Course contents

The course language is English (some specific slides may address regional or national issues and may be in Dutch, these can be translated during the lecture). During this course a limited number of lectures will be given, to introduce basic and advanced theoretical concepts of discrete event simulation and health economic modelling. Particular attention will be paid to the use of probability distributions, uncertainty analysis, and metamodeling, in the context of advanced simulation models. Specific scientific background papers will be made available to learn in more detail about these concepts and their use.

A series of practicals is scheduled to build up experience and work on the different tutorials and assignments (see below), to get feedback of the lecturers, and to ask questions. In addition to the practicals a large number of self-study hours is allocated to working on the main assignment

## **All tutorials and and the main assignment are to be performed in pairs, not individually**.

*You can enlist in pairs on Canvas.*

## Course tutorials

Before starting on the main course assignment you will build up experience using R/Simmer to build and use DES models. To help you gain this experience the following tutorials are included:

- *Tutorial part 1*: Learning how to use R/R-Studio.
- *Tutorial part 2*: Learning how to use the Simmer in R to develop and use DES.
- *Tutorial part 3*: Develop a simple DES for lung cancer diagnosis and treatment, using available data (with missing values), R functions, and probability distributions.

## Main course assignment

The core component of this course will consist of a large assignment (in two parts) reflecting a health economic case study. The case study will concern optimizing the treatment of patients with metastatic colorectal cancer, by tailoring chemotherapy based on their diagnostic test results.

*Two parts make up this main assignment:*

- Part 1: Health Economic Modeling: Implementation of the control strategy – that is, reflecting current 'care as usual' in this patient group
- Part 2: Health Economic Modeling: Implementation of the experimental strategy – that is, reflecting a new care pathway making use of 3 new diagnostic tests. Finishing the model, performing final analyses and interpretating the results.

Note 1: Even though this course focuses on general skills related to DES in R, interpretation of the results of your DES analysis in Part 2 requires basic understanding of the health economic context, as explained in the first two course lectures (HC-1, HC-2).

Note 2: You need to submit both assignment parts through Canvas – for the respective elements to submit and corresponding deadlines see the *Course schedule* above.

## Course examination

Examination, per pair of students, will be based on the final reflection report to be submitted through Canvas before the corresponding deadline (see *Course schedule*). The requirements for this report are as follows:

A final report, including reflection, needs to be handed in, with a front page (including student numbers and group number, max 1 A4), and with separate sections for

- Part 1 and 2 of the assignment (max 10 A4 for part 1 and 2 combined)
    - Describe and motivate the choices you made during data analysis steps, design of the DES model, the simulation results, and the interpretation of these results.
    - Consider:
        - A description of competing risks and how these are handled in the model.
        - Describe the conditionality of probabilities included in the model, and how these probabilities were derived from the data.
        - A description of how the tests were included into the model structure. Also, provide a description of how test thresholds were determined, and provide threshold values.
        - Include a description of all parameter distributions and the rationale for choosing a certain distribution.
- Feedback provided: summary of feedback your provided to another group (max 1 A4)
    - Describe which modeling/coding aspects you focused on and briefly describe the feedback you provided.
- Feedback received: summary and use of the feedback received (max 2 A4)
    - Describe the feedback you received, if you agreed with the points raised, the insight this feedback provided you with, and how you would adapt your model accordingly (no actual change to the model/code is required).
- Overall reflection: discussing the course as a whole (max 2 A4).
    - Briefly discuss your approach to the assignment, your collaboration in pairs, challenges encountered, what you learned from this course, if/how this course relates to other courses, and your view on the application of DES for health economic evaluations.

The final reflection report is not allowed to exceed 1+10+1+2+2 = 16 pages, using font size 11 or larger, single line spacing, and margins ≥ 2cm on all sides, including all figures and tables. Appendices are not allowed.

Reports that do not comply with the above formatting requirements, or maximum size, will not be graded, and automatically result in a grade of 1.

## Course grading

For grading of this course, based on the the final reflection report see the **Assessment criteria (Excel file) on Canvas.**

Please note:

- A grade will be awarded to each pair of students, as the simulation model assignment will be performed in pairs, and the corresponding reflection report will also be written in pairs. No unique grade will be provided per student.
- The grade is based on your final reflection report, *not on your actual model or code*. This means that (correct) choices and decisions you make during model development are not taking into account in the grading process **unless** you described these clearly in your final report!

## Additional course comments

Given the technical nature of this course, unexpected technical problems could potentially arise when working on the tutorials or assignment. Students are requested to inform the lecturers as soon as possible of any software-related issues they encounter which could influence their progression with the assignments, so these can be addressed without any delays.