

MODELING HEALTH AND ECONOMIC OUTCOMES USING DISCRETE EVENT SIMULATION IN R

A FIVE-DAY PRACTICAL COURSE PROVIDING ALL
KNOWLEDGE AND TOOLS REQUIRED TO IMPLEMENT
DISCRETE EVENT SIMULATION MODELS IN R

- NO MODELING KNOWLEDGE REQUIRED
- HANDS-ON EXERCISES EVERY DAY
- DINNER WITH THE EXPERTS

9 - 13 MARCH 2020
UTRECHT, THE NETHERLANDS

UNIVERSITY
OF TWENTE.

MODELING HEALTH AND ECONOMIC OUTCOMES USING DES IN R

There is an increasing need for patient-level simulation modeling methods to perform health economic evaluations or translational research on, for example, the optimization of treatment sequences. Discrete event simulation is a patient-level simulation modeling method well suitable for modeling clinical pathways, allowing for patient and disease characteristics and resource constraints to be reflected. It offers much more flexibility of model structure than the traditionally used cohort simulation models. However, it is often thought that this increase in flexibility comes at the expense of increased complexity compared to cohort models and compared to other individual patient modeling methods, such as patient-level state-transition modeling. This perceived complexity mainly originates from a stronger body of guidance on, and broader experience with, state-transition modeling. In fact, modelers familiar with discrete event simulation typically argue that using discrete event simulation results in models that are more transparent and also easier to interpret when reflecting personalized clinical pathways. This course aims to bridge the knowledge and experience gap on the use of discrete event simulation by providing participants with all theory and hands-on experience required to utilize the full potential of discrete event simulation to model health and economic outcomes.

The 'Modeling health and economic outcomes using discrete event simulation in R' course in brief:

- Five-day course with a 'Learning R for Simulation Analyses' day
- Focus on using discrete event simulation for modeling health and economic outcomes
- Half of the course time is spent on guided hands-on practical sessions in R
- Guest lectures on related modeling topics by renowned experts, and dinner with the experts
- Convenient packages including accommodation during the course

Discrete event simulation for modeling health and economic outcomes

This course focuses on using discrete event simulation for modeling health and economic outcomes of personalized clinical pathways, which goes beyond direct comparisons of healthcare interventions in standard health economic analyses (i.e., cost-benefit, cost-effectiveness, and similar analyses). Therefore, participants will not only be trained to develop discrete event simulation models that can be used to perform health economic analyses of specific treatment strategies but also to develop models that can be used to inform clinical study designs and identify optimal treatment (sequencing) strategies. Based on state-of-the-art methodological guidance, all theoretical background required for implementing discrete event simulation will be discussed, starting from conceptualizing the model structure through analysis of the final model.

More specifically, the following aspects of discrete event simulation for modeling health and economic outcomes will be discussed:

- Conceptualization of the model structure
- Implementing competing events
- Individual patient data analysis
- Discounting for discrete event simulation models
- Reflecting stochastic and parameter uncertainty
- Base-case and probabilistic model analyses

Hands-on practical sessions with expert coaches

Although a good theoretical understanding of discrete event simulation is essential and will be provided, half of the course time is spent on practical sessions in which participants will learn to implement discrete event simulation models in R. During these practical sessions, participants will be coached by experts to allow each participant to successfully complete all assignments. Seven practical sessions will empower participants to implement any type of discrete event simulation model in R using the `simmer` package. The same case study on modeling health and economic outcomes will be used throughout all practical sessions, resulting in an oncology treatment sequencing model including biomarker-based treatment decisions for multiple lines of treatment and follow up. Throughout the development of this simulation model, all previously mentioned aspects to implementing a discrete event simulation will be covered. Participants will be provided with answers and source codes throughout practical sessions and each practical session will include optional, more advanced assignments for those progressing through the assignments fast, for example, because they are already familiar with some of the concepts.

Required knowledge of health economics, simulation modeling, and R

Focus in the course is on the use of discrete event simulation to model health and economic outcomes, so only a brief discussion of health technology assessment (HTA) and health economic modeling (HEM) in general will be included. To introduce those unfamiliar with the health economic modeling context, background materials will be provided prior to the course in order to prepare for a brief introduction to this context. It is helpful for participants to have some experience with building health economic models or simulation models in general. For example, experience with developing cohort-level state-transition models (i.e., Markov models), will be beneficial. Similarly, any experience with R prior to the course will be valuable when learning to use R for simulation purposes. All practical sessions will concern programming discrete event simulation models in R using the `simmer` package. Therefore, the first day will provide participants with knowledge about the basic concepts required to perform simulation-based analyses in R, which is crucial to the successful completion of the course.

Course structure and detailed program

Apart from the first course day, which focuses on using R for simulation analyses, a typical course day exists of a morning lecture discussing theoretical aspects of applying discrete event simulation for modeling health and economic outcomes, followed by an elaborate practical session to directly apply discussed theory into practice. Course days end with a guest lecture by renowned experts from different, but related fields, and a dinner to further interact with these experts.

A detailed program is available at the end of this brochure.

Course instructors



Dr.ir. Erik Koffijberg (course leader)

Erik Koffijberg has a background in Technical Computer Science and over 15 years of experience as health economist and modeler. He holds a position as Associate Professor within the Health Technology and Services Department at the University of Twente. He develops and teaches educational modules on the development and interpretation of health economic models in several post-graduate master courses and international workshops. He has published over 100 scientific papers related foremost to simulation model based impact assessment of new healthcare technologies.

E-mail: h.koffijberg@utwente.nl



Dr. Koen Degeling

Koen Degeling is an Industrial Engineer by training and specialized in the use of operations research methods within health care. He holds a position as Research Fellow within the Cancer Health Services Research Unit at the School of Population and Global Health of the University of Melbourne. Koen obtained the degree of doctor for his thesis “Simulation Modeling to Optimize Personalized Oncology”. He has developed several introductory and advanced courses and workshops on using simulation modeling methods in health care.

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Drs. Michiel van de Ven

Michiel van de Ven has a background in Economics and Health Economics. He holds a position as a Ph.D. candidate within the Health Technology and Services Department at the University of Twente. In his research, he uses real-world data and simulation modeling to evaluate the optimal implementation of complex health technologies.

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Next to the course instructors several external simulation modeling experts will also contribute to the course program, to quickly bring you up to speed regarding related modeling techniques and related application areas within healthcare.

Course packages and venue information

To stimulate an interactive environment and to allow for substantial coaching during the practical sessions, there is a maximum of 20 participants.

The course venue is the Van der Valk Hotel Utrecht, Winthontlaan 4, 3526 KV Utrecht, Netherlands. This convenient venue is easily accessible by public transport or car, and only a short travel away from Amsterdam Schiphol Airport. Accommodation at the hotel during the course is available. For more details on the venue see <https://www.vandervalkhotelutrecht.nl>

Two different course packages are available, with the most comprehensive option allowing you to also directly book accommodation including breakfast along with the course. Both packages include coffee and tea throughout the day, lunch, a 3-course dinner with experts (on Friday there will be no dinner but a reception), and parking:

- Package 1 Full DES course (5 days) €2250,-
- Package 2 Full DES course (5 days) with accommodation (4 nights + breakfast) €2850,-

Registered PhD students are eligible for a discount on the course packages of €450.

To obtain this discount a request - accompanied by an official certificate of enrolment including their name in the corresponding Graduate School- should be sent to the course leader by email.

Registration

Registration for the course is processed through an online system that is available through the link below. As soon as the maximum number of 20 participants is reached, registration will no longer be possible, but subscription to a waiting list is possible by contacting the course leader (see contact details above). Cancellation of registrations is possible with full refund until December 1, 2019. Cancellation between December 1 and January 29 will result in a 50% refund. After January 29 no refund is provided.

REGISTRATION DEADLINE FEBRUARY 27

Register here to participate in this course

<http://bit.do/desmodeling>

Please contact the course instructors for questions or enquiries (see contact details above).

DETAILED COURSE PROGRAM

DAY 1*, MONDAY 9 MARCH 2020

BLOCK	START	END	CONTENT
	9.00	9.30	Registration
1	9.30	11.00	1.1 Welcome <ul style="list-style-type: none">• Introductions and course overview 1.2 PRACTICAL: Using R for Simulation Analyses <ul style="list-style-type: none">• Overview of the “Using R for Simulation Analyses” course• Working with R Studio• Source codes, data files, and packages
	11.00	11.15	Coffee break
2	11.15	12.30	2.1 PRACTICAL: Using R for Simulation Analyses (<i>continued</i>) <ul style="list-style-type: none">• Data structures: variables, vectors, matrices, data.frames, lists• Sub-setting and selecting from data structures• Basic calculations and transformations
	12.30	13.30	Lunch
3	13.30	15.30	3.1 PRACTICAL: Using R for Simulation Analyses (<i>continued</i>) <ul style="list-style-type: none">• Working with functions• Defining custom functions• Making basic plots• Efficient vector and matrix based calculations• Parallelization
	15.30	16.00	Coffee break
4	16.00	17.30	4.1 PRACTICAL: Using R for Simulation Analyses (<i>continued</i>) <ul style="list-style-type: none">• Working with formulas• Fitting (logistic) regression models• Fitting parametric survival models• Simulating random numbers from distributions 4.2 Closing remarks
	17.30	19.30	Dinner

* Specifically, for those participants with extensive knowledge of R for simulation modeling there may be an option to skip this first day of the course. A checklist is provided at the end of this brochure to clarify what the required level of knowledge of, and experience with R is. If you have this required knowledge, please contact the course instructors prior to registering online to discuss the option of starting this course on Day 2.

DAY 2, TUESDAY 10 MARCH 2020

BLOCK	START	END	CONTENT
1	9.00	10.30	1.1 Welcome 1.2 Introduction to Health Economic Modeling <ul style="list-style-type: none">• Health Economic Modeling – context and basic techniques• Decision Trees and Markov cohort models
	10.30	11.00	Coffee break
2	11.00	12.30	2.1 Comparison of advanced modeling methods <ul style="list-style-type: none">• System dynamics• Patient-level state-transition modeling• Discrete event simulation• Agent-based modeling 2.2 Discrete event simulation: basics <ul style="list-style-type: none">• Potential applications in health care• Introduction to time-to-event modeling
	12.30	13.30	Lunch
3	13.30	15.30	3.1 Introduction to the case study that is used throughout the course 3.2 PRACTICAL: Introduction to SIMMER <ul style="list-style-type: none">• Fundamental elements• Basic building blocks• Implementing basic trajectories
	15.30	16.00	Coffee break
4	16.00	17.30	4.1 PRACTICAL: Introduction to SIMMER (<i>continued</i>) <ul style="list-style-type: none">• Running simulations• Observing outcomes 4.2 Closing remarks
	17.30	19.30	Dinner with the course instructors

DAY 3, WEDNESDAY 11 MARCH 2020

BLOCK	START	END	CONTENT
1	9.00	10.30	1.1 Welcome
			1.2 Discrete event simulation for Health Economic Modeling (Part 1) <ul style="list-style-type: none">• Modeling competing events<ul style="list-style-type: none">○ Different approaches○ Data analysis for the different approaches○ Simulation for the different approaches○ Guidance on selecting between approaches
	10.30	11.00	Coffee break
2	11.00	12.30	2.1 Introduction to the practical session
			2.2 PRACTICAL: Basic model structure <ul style="list-style-type: none">• Initializing patient attributes• Defining the model structure
	12.30	13.30	Lunch
3	13.30	15.30	3.1 PRACTICAL: Basic model structure (<i>continued</i>) <ul style="list-style-type: none">• Implementing the competing events• Time-to-events (deterministic)
	15.30	16.00	Coffee break
4	16.00	18.00	4.1 EXPERT PRESENTATION: Prof.dr. Erwin Hans (University of Twente) will present on using DES for optimization of healthcare logistics.
	18.00	20.00	Dinner with expert

DAY 4, THURSDAY 12 MARCH 2020

BLOCK	START	END	CONTENT
1	9.00	10.30	1.1 Welcome
			1.2 Discrete event simulation for Health Economic Modeling (Part 2) <ul style="list-style-type: none">• Discounting• Reflecting uncertainty<ul style="list-style-type: none">○ Stochastic uncertainty○ Parameter uncertainty○ Structural uncertainty
	10.30	11.00	Coffee break
2	11.00	12.30	2.1 Introduction to the practical session
			2.2 PRACTICAL: Health economic impact <ul style="list-style-type: none">• Time-to-events (stochastic)• Quality of life• Costs• Discounting
	12.30	13.30	Lunch
3	13.30	15.30	3.1 Introduction to the practical session
			3.2 PRACTICAL: Probabilistic analysis <ul style="list-style-type: none">• Bootstrapping data• Parametric distributions• Reducing simulation time through parallelization
	15.30	16.00	Coffee break
4	16.00	18.00	4.1 Dr. Veerle Coupé will present on the use of micro-simulation model to optimize cancer prevention.
	18.00	20.00	Dinner with expert

DAY 5, FRIDAY 13 MARCH 2020

BLOCK	START	END	CONTENT
1	9.00	10.30	1.1 Welcome
			1.2 Discrete event simulation for Health Economic Modeling (Part 3) <ul style="list-style-type: none">• Challenges and extensions<ul style="list-style-type: none">○ Validation○ Transparency○ Metamodeling
	10.30	11.00	Coffee break
2	11.00	12.30	2.1 PRACTICAL: Finalizing your model / Discussing your own project <ul style="list-style-type: none">• Finishing the code• Visualizing the results
	12.30	13.30	Lunch
3	13.30	14.00	Final remarks and feedback
	14.00	16.00	3.1 EXPERT PRESENTATION: Dr Talitha Feenstra (University of Groningen) will present on approaches to simulation model validation
	16.00	17.00	Closing reception

R AND R STUDIO EXPERIENCE CHECKLIST

To be able to complete this course successfully, participants will learn specific aspects of R and R Studio on Day 1 of the course. These aspects and skills are listed below. If you are an experienced R user and are confident in your ability to perform the listed tasks, please contact the course leader prior to registering online to discuss the option of starting this course on Day 2.

On Day 1, participants will become familiar with, and learn, the following:

- R Studio and its different windows
- Loading source codes and data files
- Installing and loading packages/libraries
- Defining and working with variables, vectors, matrices, data.frames, and lists
- Sub-setting/selecting from vectors, matrices, data.frames, and lists
- Basic calculations and transformations on variables, vectors, matrices, data.frames, and lists
- Working with functions (incl. using functions to define arguments to other functions)
- Defining custom functions
- Making basic plots
- Efficient vector and matrix based calculations using the “apply” functions
- Parallelization of computational tasks
- Defining and working with formulas
- Fitting (logistic) regression models
- Fitting parametric survival models
- Simulating random numbers from parametric distributions