Multivariate Markov Chain Methods in Health Care

HU-MATHS-IN
Hungarian Service Network for Mathematics in Industry and Innovations

CHALLENGES

Monitoring and cost optimisation

The Industrial Problem

Consulting companies in healthcare and health-economics are often faced with the problem of finding cost efficient therapies and therapeutic regimens and comparing them. These challenges also emerged and need to be solved at the Healthware Consulting Ltd., Budapest.

INDUSTRIAL SECTOR: HEALTHCARE AND HEALTH-ECONOMICS CONSULTING

Research unit

Markov-chain methods

Young Research Group for developing Multivariate Markov-chain methods in monitoring health-care processes

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UNIVERSITY of DEBRECEN

Simulations, cost estimation and optimisation using Markov chains with the help of custom-developed programs written in R and C++.

Company

Healthware Consulting Ltd.

HEALTHWARE

The Healthware Consulting Ltd. was founded in 2004 by with health care and health economy professionals. Over the years, due to the continuous development, the company has become a recognized health-economic consulting company in Hungary.

SZÉCHENYI 2020
MAGYARORSZÁG KORMÁNYA
Európai Unió
Európai Strukturális és Beruházási Alapok
BEFEKTETÉS A JÖVŐBE

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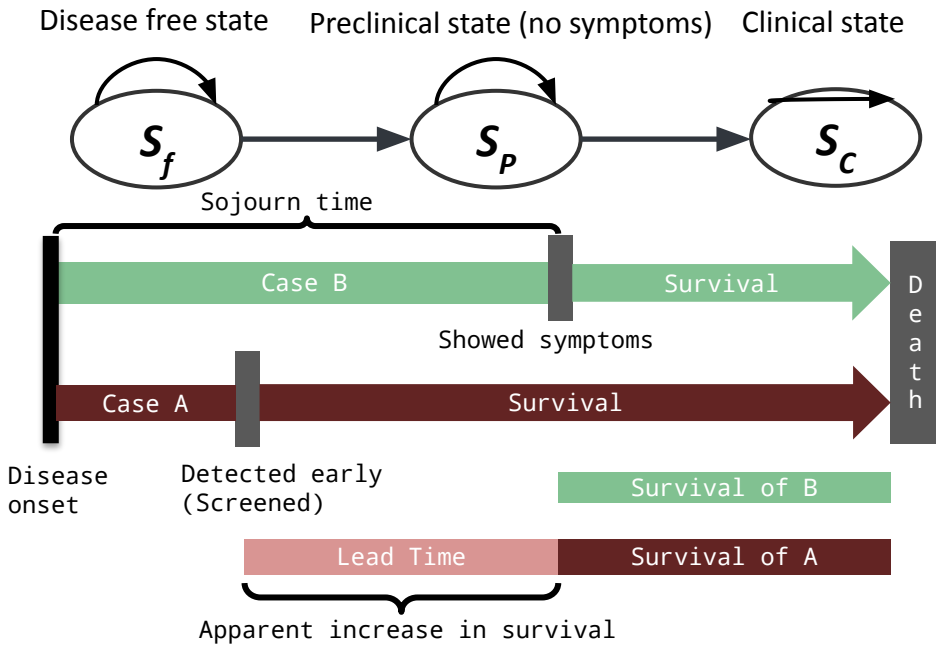
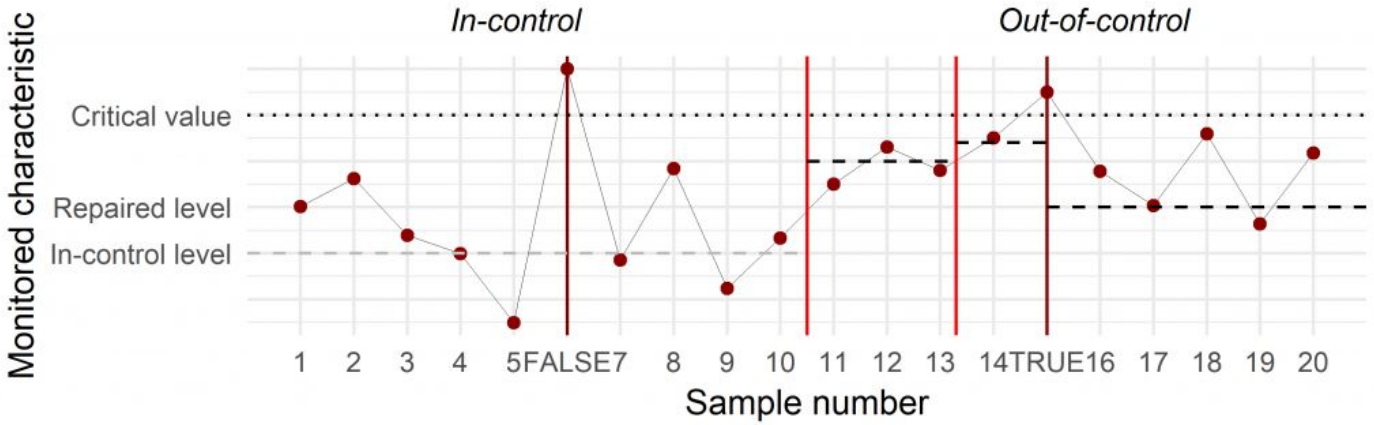
Challenges & Goals

- To develop cost-optimisation methods, which are applicable to different medical processes
- To incorporate the mathematical methods into a comprehensive R package
- To study the performance of the of the convolution based disease progression model and investigate the identifiability of the parameters

Chronic disease progression:





Disease states in chronic diseases (right) and disease progression-treatment cycles (bottom)

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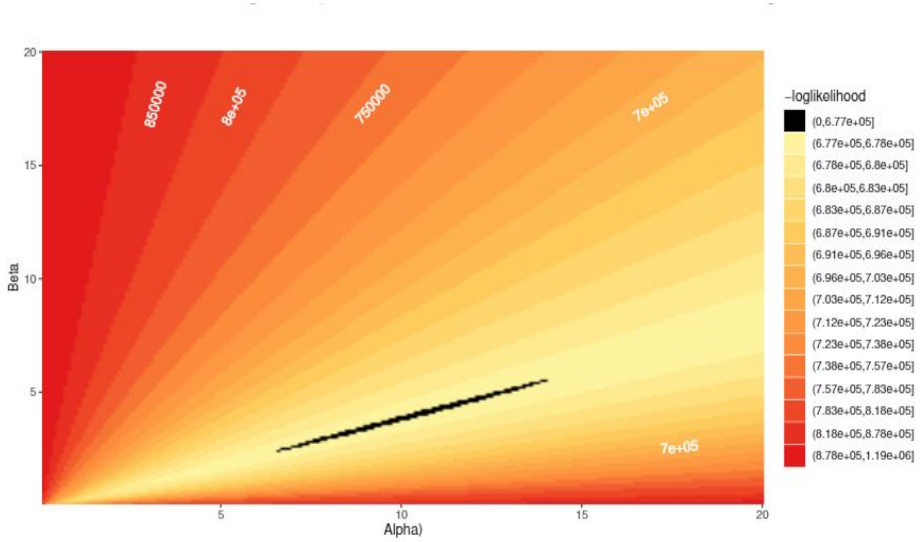
Mathematical and computational methods and techniques applied

- Simulation of disease progression as using different parameterizations to study it's performance
- New Markov chain-based control chart methods for continuous treatment cost modelling by a modified, highly parametrizable cost function
- Implementation of results into R
- New methods to investigate the identifiability of the parameters of convolutions of random variables
- Exposed the sensitivity of classic disease progression models to the underlying assumptions



Contour plot of the –loglikelihood under the classical convolution based model for a gamma distributed sojourn time with parameters alpha and beta, the confidence region is in black

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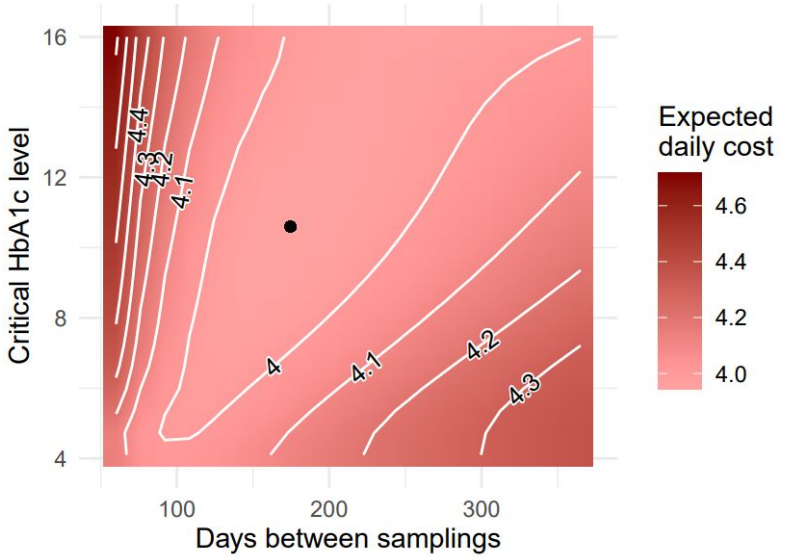
Results & Benefits to the company

- Powerful simulator of disease progression and screening programs
- Useful methods for proving identifiability in convolution setups
- Publication of the updated Markovchart R package on the Comprehensive R Archive Network
- Successful application of the Markovchart package to real-world medical data
- The results were presented at a conference (together with the Healthware Consulting Ltd.)
- One new publication, one submitted manuscript and one completed manuscript



Contour plot of expected costs (EUR) related to insulin analogue therapy; HbA1c: glycated haemoglobin (blood sugar) level.

The industry has powerful simulators and R programs to estimate parameters and optimize costs