MONITORING and COST OPTIMISATION in HEALTHCARE by MARKOV CHAIN METHODS

CHALLENGES: Monitoring and cost optimisation

PRODUCTIVE SECTOR: Healthcare and health-economics

PROBLEM DESCRIPTION

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.

CHALLENGES AND GOALS

• To develop cost-optimisation methods, which are applicable to different medical processes
• To incorporate the mathematical methods into a comprehensive R package
• To create a disease progression model which can be used to accurately estimate the sojourn time and correct the lead time bias

MATHEMATICAL AND COMPUTATIONAL METHODS

The main methods and the connected problems are as follows:
• Simulation and modelling disease progression as a gamma deterioration process
• A Markov-chain-based model which incorporates sickness level that can be used for estimation of the parameters governing disease progression which allows optimizing treatment costs
• R programs for cost calculation (using cycle-based approach), optimisation (using the L-BFGS-B algorithm), simulation (using the Markov property) and visualisation (contour plots)
• Determine the effects of the parameters governing the process on the optimal screening strategy

All of these methods required the development of new theoretical results (such as the estimation of costs between control visits) as well as extensive programming in C++ and R. This meant the creation of new, purpose-built functions for theoretical calculations and simulations.


Disease progression-treatment cycles
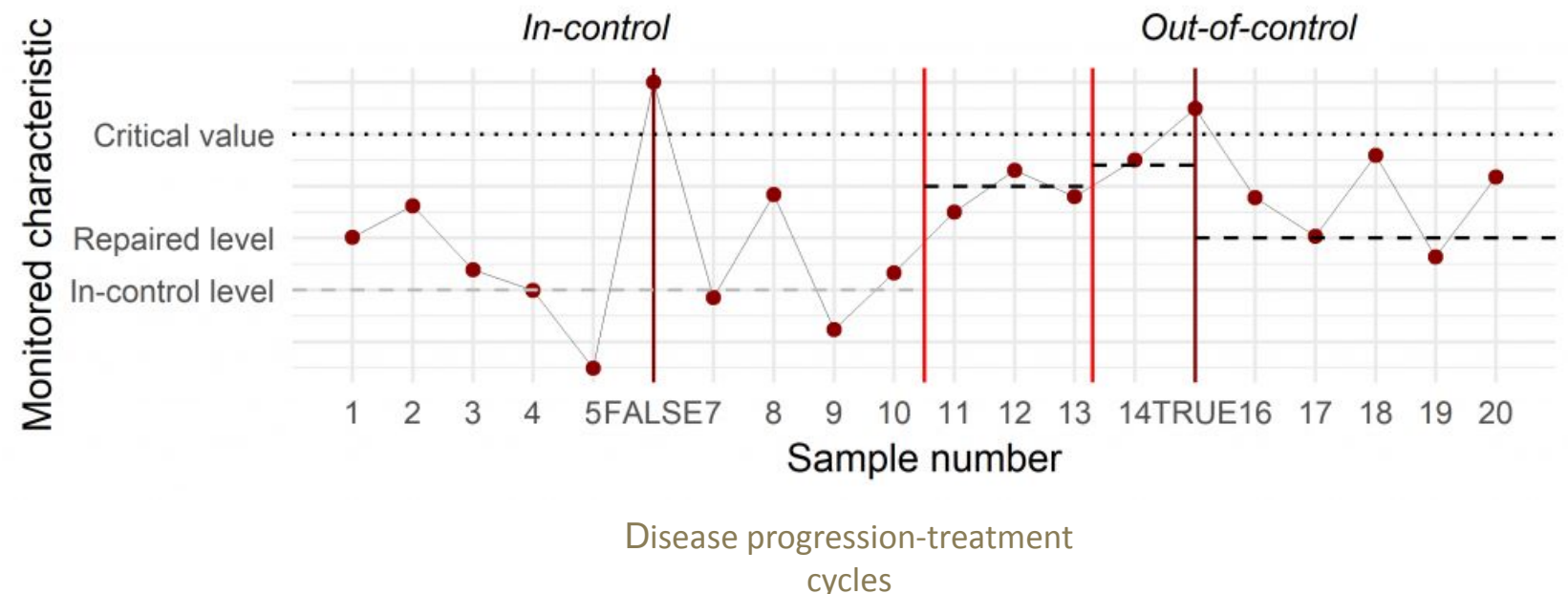
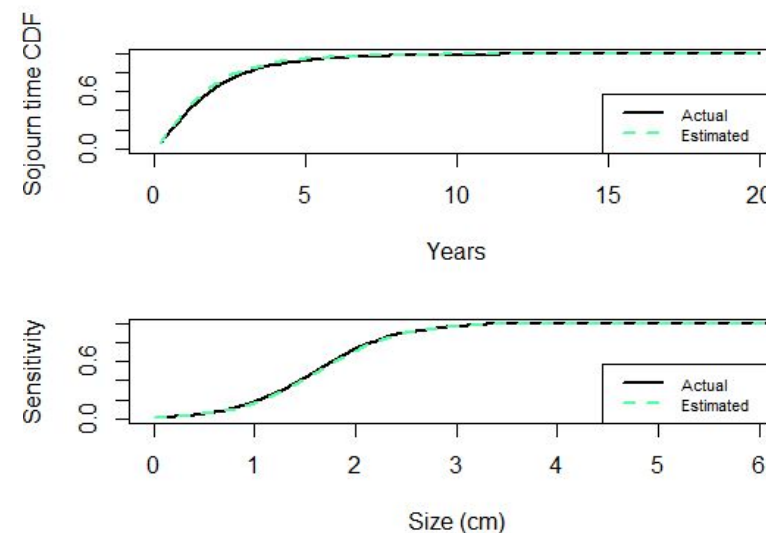# MONITORING and COST OPTIMISATION in HEALTHCARE by MARKOV CHAIN METHODS

Results and Benefits

We achieved accurate estimation of sojourn time, based on the level of sickness at diagnosis, and in this model we introduced cost-optimal screening schemes. We also published the Markovchart R package on the Comprehensive R Archive Network and applied it to real-world medical data. The results were presented at several conferences (one together with the Healthware Consulting Ltd.) and as two new publications in international journals.

The industry has powerful simulators and R programs to estimate parameters and optimize costs.
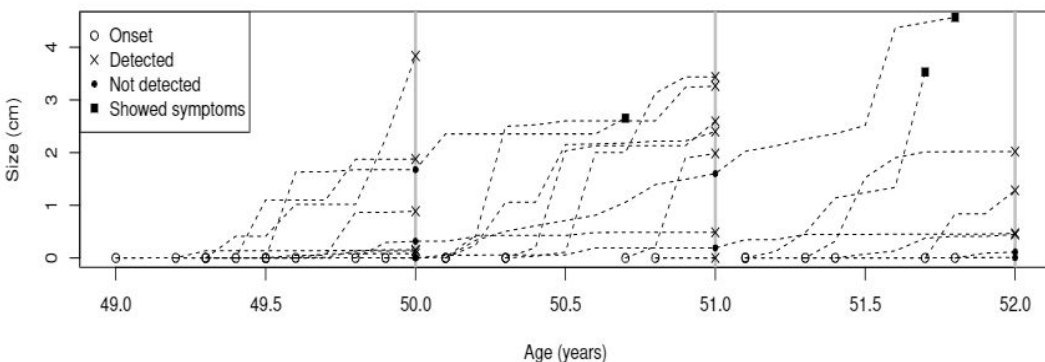
Simulated breast cancer tumor growth and detection by screens, and modelling tumor size by a gamma process

Actual vs estimated breast cancer sojourn time and screening sensitivity

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

Research Group for developing Markov-chain methods in monitoring healthcare processes

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MAGYARORSZÁG
KORMÁNYA
BEFEKTETÉS A JÖVŐBE

HEALTHWARE

Healthware Consulting Ltd.