Success Story
COMET

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DEXHELPP
Decison Support for Health Policy and Planning
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K-Projects
COMET subproject, duration and type of project:
Burden of Disease, [07/2014 – 06/2017], multi-firm

A Generic Population Model (GEPOC)

Simulation models for aspects of the health system often require an underlying population model, which require substantial resources in the modelling process. GEPOC collects population data and implements population models to have them readily available. Models are designed to be extended for healthcare aspects to make future projects faster and more efficient. Above that, this allows reproducible use of data and standardized transferability to other countries. As proof-of-concept, GEPOC was applied on a vaccination model in 2016.

Motivation

Simulation models are a common way to perform analysis and planning in the healthcare system. Often, data does not directly provide answers and statistical analyses are insufficient.

In the past, dwh Simulation Services conducted several projects in Austria that included modelling and simulation. Agent-based models were developed to simulate the outcome of vaccinations for streptococcus pneumoniae and influenza. Another model analysed cost effectiveness of screening for Abdominal Aortic Aneurysms. In another project, an agent-based model was developed to compare the costs of healthcare in different reimbursement systems. These models addressed completely different issues and answered completely different questions. However, each model needed a valid representation of Austria's population, and structures to simulate changes like births or deaths. Each project spent substantial resources to do the same thing again and again.

Therefore, an idea was born: A **GE**neric **PO**pulation **C**oncept – GEPOC – should provide appropriate structures and model parts about the Austrian population. This should substantially decrease the effort of population modelling, and further the total effort of modelling projects in the future.

Outline

GEPOC is a joint development in DEXHELPP by dwh Simulation Services, TU Wien, UMIT, and Synthesis Forschung.

GEPOC generally consists of three parts: A handbook, model implementations, and data.

The **handbook** contains a literature review on other population models, lessons learned from past projects, and comprehensive documentation of collected data and implemented models.

Model structures were implemented as agent-based models in Java and Python, and as a System Dynamics (SD) model in Anylogic. These combinations of implementations serve a wide range of projects conducted by DEXHELPP partners. All models are able to simulate a population of humans with age and sex, including births, deaths, immigration, and emigration over a period of several years.

The **data** about Austria's population, including births, deaths, immigration, and emigration, was collected from Statistics Austria. The data com-

bmwfw Federal Ministry of Science, Research and Economy
bmvit Austrian Ministry for Transport, Innovation and Technology

poses of data until 2014 and predictions until 2050. The total population's prediction is a result of Statistics Austria's own population model. The handbook describes the sources of this data, the pre-processing and storage format, and the mathematical calculations for model parameters.

Validation

Both the AB and the SD model were simulated for Austria's population from 2003 until 2050, using the initial population in 2003 and births, deaths, immigration, and emigration data for 2003-2050. For validation, the resulting model population was be compared to the total population data.

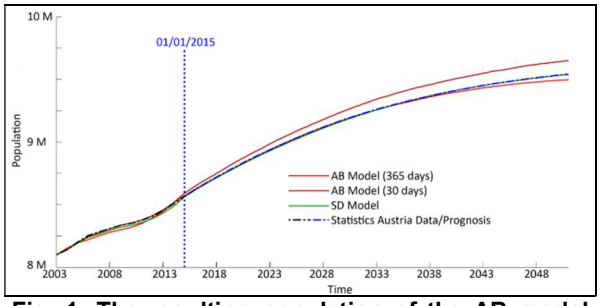

Fig. 1: The resulting population of the AB model (with 365 and 30 days time steps) and the SD model compared to Statistics Austria's data.

Figure 1 shows that this works fairly well. The SD model exactly resembles Statistics Austria's population prediction. The AB model contains small differences, which are acceptable and trace back to complex parameter calculation. Further research addresses this issue to minimize the differences.

Impact and effects

The population models are able to reproduce Statistics Austria's data. Thus, they can be considered valid and serve as a basis for further modelling. This is the function that the pure population data cannot provide. The models are designed in such a way that they can easily be extended for diseases, treatments, and other healthcare interventions (Figure 2). The population model, which serves as a necessary core of the model, can perform a standalone simulation of the population. The section "Results" show that it reproduces, and thus can be considered valid.

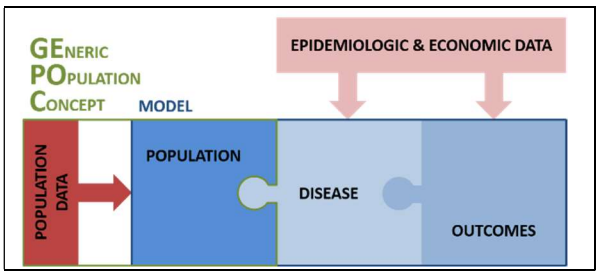

Fig. 2: GEPOC is a model

As proof of concept, dwh Simulation Services applied the agent-based Python model to simulate vaccination rates in Austria for the Austrian Ministry of Health. Information was available about yearly vaccination numbers in Austria, disease outbreaks, as well as vaccination state of immigrants and refugees. As a result, the model shows vaccination and immunity states of Austria's population for each birth cohort. This analysis allows performing specific measures for children vaccinations and catch-up vaccinations to reach the health goals concerning the disease.

GEPOC provides population data readily available and allows to use it in a well-defined reproducible way. The implemented models are designed to be used for healthcare issues and significantly reduce resources, time and cost of modelling projects. Data and models can easily be updated whenever new data is published. Data handling and models can even be transferred to simulate other countries without any major changes.

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