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Integration of field-based and agent-based modelling paradigms into the PCRaster environmental modelling platform

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The construction of simulation models to perform e.g. hydrological, ecological, or health studies often requires the combination of fields representing spatially distributed values (e.g. elevation, land use or contamination) and agents representing individual objects (e.g. trees, agricultural farms, or humans). However, the integration of fields and agents in models is still complex from the perspective of model implementation, as conventional agent-based and field-based software tools use different internal representations of data, space and time. In addition, a convenient way to access these different representations by means of an environmental modelling language is absent and therefore complicates the development process for environmental scientists.

We developed LUE, a conceptual and physical data model capable to represent fields and agents. The conceptual data model is a generalisation of field-based and agent-based data models. The physical data model is an implementation of the conceptual data model in HDF5. Our LUE data model is part of a new modelling language, allowing for operations accepting both fields and agents as arguments, and therefore resembling and extending the map algebra approach to modelling. We currently reuse the field-based operations provided by the open-source PCRaster environmental modelling platform (http://www.pcraster.eu) in our new modelling language, and gradually extend the operations to also process agents.

In our presentation we demonstrate the key concepts of the LUE data model and its usage with practical Python examples to model, for instance, accessibility to restaurant locations in the Netherlands or temporal variation of air pollution exposure analysed for large cohorts. In addition, we show that field-based stochastic spatio-temporal models can be constructed with the PCRaster software. We also address the latest novelties in the PCRaster package, amongst others the support of Python 3.6, the “multicore” module providing about 50 multithreaded field-based operations, improvements in large dataset support on Windows and the modernised build infrastructure allowing for simpler builds on Unix-like platforms.