IMPROVED DECISION SUPPORT SYSTEMS: ENHANCED SPATIALLY DISTRIBUTED MODEL CALIBRATION

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RISK MITIGATION REQUIRES UNDERSTANDING THE IMPACT OF LAND USE PLANNING AND MANAGEMENT ON HAZARD EXPOSURE AND VULNERABILITY. WELL CALIBRATED SPATIALLY DISTRIBUTED MODELS MAY BE USED TO PROJECT IMPACTS OF LAND USE POLICY INTO THE FUTURE, WITH CELLULAR AUTOMATA BEING A FAVOURABLE EXAMPLE FOR THEIR SIMPLICITY AND FLEXIBILITY. THIS RESEARCH AIMS TO DETERMINE A MORE EFFICIENT CALIBRATION PROCEDURE FOR THESE MODELS.

INTRODUCTION

Cellular Automata (CA) integrate mathematical theories of self-reproduction in automata with a 2-dimensional raster in cartographic space. Applied to land use modelling, CA simulate land use patterns through the use of land use transition rules at the cell level, where these rules are calibrated using historical data sets to ensure the model is an accurate representation of reality.

CA can be used extensively for disaster mitigation planning with the ability to simulate land use to identify optimum planning strategies to mitigate disaster risk. CA are now starting to be applied in Australia for this purpose.

Modelling Advantages:

- Ability to reproduce complex emergent dynamics from simple rules;
- Low data requirements;
- Computational efficiency
- Existence of a number of CA modelling frameworks for simulating land use change

RESEARCH FOCUS

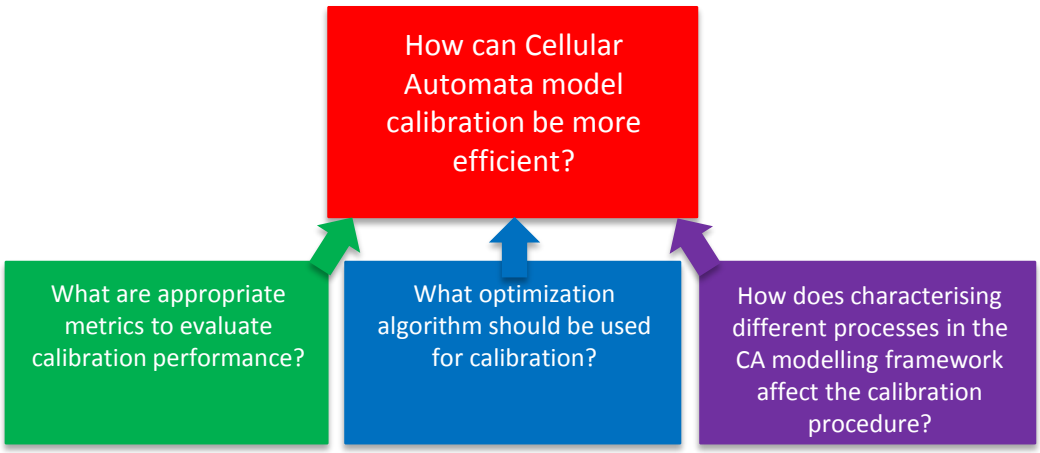
A major drawback of CA models is the need to specify and calibrate transition rules. This is commonly done manually, which is time consuming and requires expert knowledge. This manual approach also means calibrated parameters are unlikely to be near-optimal.

This research aims to improve the efficiency of the calibration procedure. This requires answering the research questions outlined above.

METHODOLOGY

This research will be conducted using the Metronamica modelling framework (www.metronamica.nl) . Various metrics and optimisation algorithms will be investigated to find more efficient calibration procedures, that will be (semi) automated.

RESEARCH QUESTIONS:



Proposed Studies:

Study 1: Parameter Sensitivity Analysis

Analysis of process representation within models

The CA framework requires that model behaviour is realistic, ensuring the model has process accuracy. This study focuses on the sensitivity of parameter values, that represent processes within the model, examining how simulated land use changes with alterations to parameter values. Part of this study will evaluate whether the adjustments during the sensitivity analysis can be captured by metrics.

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Study 2: Metric Utility Study

Analysis of metrics for use in an automated calibration procedure

There are a vast array of metrics that can be used for calibration. This study specifically looks at usage for an automated procedure, assessing how well changing drivers are captured by metrics and how metrics should be used in an automated procedure (combination, weighting, ranking). It must ensure land use processes are captured well and parameters remain plausible during calibration.

Study 3: Efficiency Study

Integration of metrics and optimisation algorithms

There exist many different multi-variable optimization paradigms based on traditional optimisation theory, and analogical heuristics. This study will identify the most efficient algorithms for calibration, and will also identify the most effective formulation of the optimisation problem based on the previous two studies.

Study 4: Generalization Study

Does the automatic calibration procedure generalize to other CA modelling frameworks

This study will test whether the automatic calibration procedure developed for Metronamica can be applied to other CA modelling frameworks. This could include different land use models as well as different modelling applications such as floods and bushfires.