Modelling with cellular automata: problem solving environments and multidimensional applications
Naumov, L.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Contents

1 Introduction ................................................. 1
   1.1 The Third Paradigm .................................. 1
   1.2 Problem Solving Environments for Simulations ............. 3
   1.3 Cellular Automata for Simulations ..................... 7
   1.4 Thesis Outline ...................................... 10

2 Problem Solving Environment for Cellular Automata Based Simulations .... 11
   2.1 Features and Requirements .......................... 11
   2.2 Survey of Existing Cellular Automata Based Problem Solving Environments ............................................. 14
   2.3 Cellular Automata Based Problem-Solving Environment Case Study: The CAME\&L Project .................. 18
      2.3.1 Cellular Automata Based Computational Experiment Decomposition ............................................. 19
      2.3.2 Software Design .................................. 20
      2.3.3 Features ........................................ 22
   2.4 Conclusions .......................................... 27

3 Exploring Evolving 1D Structures and 2D Universal Data Indexing .... 29
   3.1 Classification of Structures Generated by 1D Binary Cellular Automata from a Single Seed ......................... 29
      3.1.1 Specification of the Transition Function .......... 30
      3.1.2 Initial Conditions ................................ 31
      3.1.3 Comparison of Grids’ States as a Basis of Classifications ... 31
      3.1.4 Invariance with Respect to the Operation “Equality” .... 33
      3.1.5 Invariance with Respect to the Operations “Equality” and “Inverse” ............................................. 36
      3.1.6 Invariance with Respect to the Operations “Equality” and “Mirror Reflection” .......................... 38
      3.1.7 Invariance with Respect to the Operations “Equality”, “Inverse”, and “Mirror Reflection” ............... 39
      3.1.8 Invariance with Respect to the Operations “Equality” and “Inverse-Mirror Reflection” ............... 40
      3.1.9 Classification with a Single-Cell Offset ............ 40
      3.1.10 Classification with Errors ........................ 41
3.1.11 Discussion .............................................. 42
3.2 Generalized Coordinates for Cellular Automata Grids .......... 43
  3.2.1 Basic Concepts ........................................ 44
  3.2.2 Spiral Generalized Coordinates ......................... 47
  3.2.3 Composite Generalized Coordinates for the Grid of Triangles . 56
3.3 Discussion ............................................... 60

4 Modelling 3D Tumour Growth .................................. 63
  4.1 Introduction ............................................ 63
  4.2 Biology of Tumour Growth ................................ 64
    4.2.1 Microscopic Subphenomena .......................... 65
    4.2.2 Mesoscopic Subphenomena .......................... 71
    4.2.3 Macroscopic Subphenomena ......................... 77
  4.3 Overview of Existing Models ................................ 79
  4.4 Several Models of Tumour Growth ........................ 91
    4.4.1 General Considerations .............................. 92
    4.4.2 Algorithm 1. Basic ................................ 93
    4.4.3 Algorithm 2. Optimized ............................. 96
    4.4.4 Experiments ......................................... 98
    4.4.5 The Influence of Mitoses Rate on Growth Dynamics . 102
  4.5 Conclusions ............................................ 105

5 Summary, Discussion and Conclusions .......................... 107

A Sample Classes of Structures Generated by 1D Binary Cellular Au-
  tomata from a Single Seed .................................. 111
  A.1 Nontrivial E-classes .................................... 111
  A.2 EIMO-classes ........................................... 112

Related Publications ............................................. 115

References ..................................................... 117

Summary ........................................................ 129
  In English .................................................... 129
  In Russian (Реферат) ...................................... 131
  In Dutch (Samenvatting) ................................... 133

Acknowledgements ............................................... 135