



UvA-DARE (Digital Academic Repository)

Modelling with cellular automata: problem solving environments and multidimensional applications

Naumov, L.A.

Publication date
2011

[Link to publication](#)

Citation for published version (APA):

Naumov, L. A. (2011). *Modelling with cellular automata: problem solving environments and multidimensional applications*.

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: <https://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 Automata 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 (Резюме)	131
In Dutch (Samenvatting)	133
Acknowledgements	135