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Chapter II

Method of Systems Potential as "Top-Bottom" Technique of the Complex Adaptive Systems Modelling

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Abstract

Emergent properties of complex adaptive systems (CAS) are explored by means of "agent-based modelling" (ABM), which are compared with results from modelling on the basis of the method of systems potential (MSP). MSP describes CAS as a holistic system whereas ABM-methodology considers CAS as set of interacting "agents." It is argued that MSP is a "top-bottom" approach, which supplements ABM "bottom-up" modeling of CAS. Adap-

tive principles incorporated into CAS at the level of a holistic system exploit Lamarck's ideas about evolution, while the adaptive rules incorporated in the inner structure of CAS reflect Darwin's ideas. Both ABM and MSP exhibit the same macroscopic properties: (1) "punctuated equilibrium"; (2) sudden jumps in macro-indices; (3) cyclical dynamics; (4) superposition of deterministic and stochastic patterns in dynamics; (5) fractal properties of structure and dynamics; (6) SOC-phenomenon. ABM demonstrates these properties via simulations of the different models whereas MSP derives these phenomena analytically.

Introduction

Traditionally, in modeling the complex adaptive systems (CAS), multi-agent modelling approach (MAM) is used. The complex adaptive system is modelled as a multitude of "agents" interacting with each other in line with certain rules of adaptive behaviour. Setting the rules of the "agents'" adaptive behavior, the researcher has a possibility to trace, using the computer, the behaviour of the system with time. Lately tremendous experience has been gained in the study of macroscopic properties of such systems. As far as these properties cannot be derived from the agents' properties, they are often called the "emergent properties of the system." It has been found that dissimilar MAM-models show the same set of macroscopic emergent properties when being modeled on the computer.

Universal Emergent Properties:

- Punctuated equilibrium.
- Self-organised criticality.
- Superposition of deterministic and stochastic patterns in macroscopic dynamics.
- Discontinuous cycles.
- Catastrophic jumps.
- Self-affine dynamics of macro-indices.
- Power law for avalanche-size distribution.
- Perpetual renewal of configuration.