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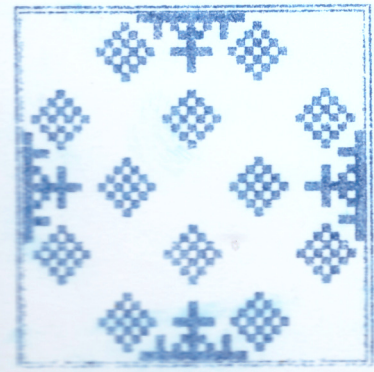


EAST KAZAKHSTAN  
STATE UNIVERSITY  
NAMED AFTER S. AMANZHOLOV

**A. Nugumanova,**  
**Zh. Sagdoldina B. Rakhadilov**

**MODELING PHYSICAL PROCESSES IN  
NETLOGO MULTI-AGENT ENVIRONMENT**

*Tutorial*



**Ust-Kamenogorsk, 2020**

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The tutorial is intended for master students studying under the programs in the field of Informatics and Physics. The tutorial contains theoretical and practical material on the topic of computer simulation of multi-agent processes and reveals the most significant aspects of its application in engineering calculations. Today without computer simulation programs it is impossible to imagine the workplace of an engineer, however, using of such programs in engineering education is lagging behind. Despite the fact that there are many commercial modeling and simulation packages available, most of them work on the principle of “black boxes”, which makes the student’s participation in the modeling process passive. This tutorial uses the NetLogo modeling and simulation environment, which allows students to actively participate in creating and debugging models.

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### Simulation software

Simulation software is based on the process of modeling a real phenomenon with a set of mathematical formulas. It is, essentially, a program that allows the user to observe an operation through simulation without actually performing that operation. Simulation software is used widely to design equipment so that the final product will be as close to design specs as possible without expensive in process modification. Simulation software with real-time response is often used in gaming, but it also has important industrial applications. When the penalty for improper operation is costly, such as airplane pilots, nuclear power plant operators, or chemical plant operators, a mock-up of the actual control panel is connected to a real-time simulation of the physical response, giving valuable training experience without fear of a disastrous outcome.

### Swarm intelligence

Swarm intelligence (SI) is the collective behavior of decentralized, self-organized systems, natural or artificial. The concept is employed in work on artificial intelligence. The expression was introduced by Gerardo Beni and Jing Wang in 1989, in the context of cellular robotic systems. SI systems consist typically of a population of simple agents or boids interacting locally with one another and with their environment. The inspiration often comes from nature, especially biological systems. The agents follow very simple rules, and although there is no centralized control structure dictating how individual agents should behave, local, and to a certain degree random, interactions between such agents lead to the emergence of "intelligent" global behavior, unknown to the individual agents. Examples of swarm intelligence in natural systems include ant colonies, bird flocking, hawks hunting, animal herding, bacterial growth, fish schooling and microbial intelligence.

### Swarm robotics

Swarm robotics is an approach to the coordination of multiple robots as a system which consist of large numbers of mostly simple physical robots. It is supposed that a desired collective behavior emerges from the interactions between the robots and interactions of robots with the environment. This approach emerged on the field of artificial swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behaviour occurs.

A. Nugumanova,  
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## Modeling physical processes in NetLogo multi-agent environment

Tutorial

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