AnyLogic –
a New Generation
Professional Simulation Tool

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Modeling

The model

Simulation

The optimized model

Analytical

World of Models

Real World

The Problem

Experiments

Too expensive or impossible

The Solution
## Analytical vs Simulation Modeling

<table>
<thead>
<tr>
<th>Analytical (e.g. Excel-based)</th>
<th>Simulation</th>
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<tbody>
<tr>
<td>• Static, mostly deterministic model</td>
<td>• Executable simulation model</td>
</tr>
<tr>
<td>+ Helps to find some solutions</td>
<td>+ Naturally captures causal dependencies and timed constraints of any complexity</td>
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<tr>
<td>+ Easy to implement</td>
<td>+ Easily captures stochastic nature of the problem</td>
</tr>
<tr>
<td>- Hard to capture time, dynamics</td>
<td>+ Can play the model behavior in detail</td>
</tr>
<tr>
<td>- Hard to capture complex causal dependencies</td>
<td>+ Enables to measure virtually anything</td>
</tr>
<tr>
<td>- Hard to model time-related constraints</td>
<td>- Takes more time and skills to develop</td>
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<tr>
<td>- Cannot play the model in time</td>
<td>- May miss a good solution or even give incorrect one</td>
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<tr>
<td></td>
<td>+ Gives better, more informed solutions</td>
</tr>
</tbody>
</table>

**FOR SYSTEMS WITH DYNAMIC BEHAVIOR:**

- May miss a good solution or even give incorrect one

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An Example: Airport Terminal

- How many check-in, security check and passport control cabins are needed?
- How many passengers airport can serve?
- How many aircrafts airport can take?
- How to organize schedule?

...
Abstraction Levels and Approaches

High Abstraction
- Less Details
- Macro Level
- Strategic Level

Middle Abstraction
- Average Details
- Meso Level
- Tactical Level

Low Abstraction
- More Details
- Micro Level
- Operational Level

Nano Level
- Individual objects, exact sizes, distances, velocities, timings, …

Aggregates, global feedback dynamics, …
- HIGH LEVEL (HLS)
  - System Dynamics (SD)
    - Levels (aggregates)
    - Stock & flow diagrams
    - Feedback loops
  - Dynamic Systems (DS)
    - Physical state variables
    - Block diagrams and/or algebraic-differential eq

Agent Based (AB)
- Active objects
- Individuals
- Behavior rules
- Direct or indirect interaction
- Environment models

Discrete Event (DE)
- Entities (passive objects)
- Flowcharts and/or networks
- Resources

Continuous media
- Elasticity of solids
- Hydrodynamics
- Aerodynamics

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- Less Details
- Macro Level
- Strategic Level
AnyLogic
A New Technology Simulation Tool

Basic simulation modeling concepts are being developed

1950s
- Block-based modeling of ODE on analog computers
- Gordon, G. *A general purpose systems simulator*. IBM Syst. J. 1962

1960s

1970s

1980s

Modern IT concepts and theories
- Object-oriented approach
- New programming languages
- Hybrid modeling theory
- Theory of distributed communicated processes
- Modern graphical user interface

1990s

New Millennium

Traditional tools

AnyLogic

AnyLogic started in 1998
AnyLogic: all abstraction levels and mix approaches

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Aggregates, global feedback dynamics, ...
- Alcohol Use Dynamics
- Flocks of Boids
- Transport Optimization
- Competition in Pulp Market
- Transport Flow
- St. Petersburg Subway
- USA Blackout
- St. Charles Subway Station
- Candy Promotion Game
- Car Suspension
- Dynamic Damper
- Crane Control
- Gas Engine

Individual objects, exact sizes, distances, velocities, timings, ...

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AnyLogic Modeling Framework

- Ports
- Messages
- Statecharts
- Timers
- Events

- Hybrid

- Discrete

- Continuous

- UML-RT

- Variables
  - ODE
  - DAE
  - NAE
  - Matrixes

- Active Objects
  - Encapsulation
  - Hierarchy
  - Inheritance

- Object Oriented
  - Java API

- Java

Ports Messages Statecharts Timers Events

Statecharts - discrete - hybrid

Variables ODE DAE NAE Matrixes

Active Objects Encapsulation Hierarchy Inheritance

Object Oriented Java API

Java
AnyLogic Professional Simulation Tool

- Discrete, continuous and hybrid modeling
- Multiple modeling approaches:
  - UML-based OO modeling
  - Block-based flowchart modeling using predefined library blocks
  - Differential and algebraic equations
  - Modeling in Java

- A strong set of concepts applicable across domains:
  - Control, traffic, ecology, …
  - Economy, business, financial, …
  - Social, epidemic distribution, etiology, …
  - Manufacturing, supply chain, logistics, …
  - Telecom, networks, protocols, hardware, …
  - Mechanics, chemical, material handling, …
  - Education, military - and more…
AnyLogic - basics

• Java
• OO-approach, UML-RT
  – Active objects, messages, statecharts, timers, etc., etc., etc.
• Hybrid dynamic system theory
  – Algebraic-differential equations, hybrid automata
• Theory of communicated sequential processes
• Best ideas of traditional simulation approaches
  – Visual specification, Flowcharts, Block diagrams, System Dynamics, ...
• > 20 years of research
  – Research projects for HPLabs, Philips, Siemens, Samsung, IBM, AFRL, ...
• > 10 years of SW product and simulation model development
  – SW products: COVERS, ModelVision, xjCharts, AnyStates, AnyLogic
Two Stages of Modeling in AnyLogic

Reducing complexity/flexibility

- Visual model development
  - Active objects, structure and behavior
  - Continuous / discrete
  - Predefined library objects
- Visual animation development
- Use all power of Java if needed

The ultimate goal is analysis, not model development!

- Run the model
  - Interactive control of model execution
  - Support of debugging and calibration
- Rich set of experimental stuff
  - Sensitivity, optimization, stochastic, ...
- Integration, interoperability
  - DB and Spreadsheet interface
  - Interface with external hardware and SW
AnyLogic – State of the Art

• Dozens of companies use AL

• Universities all over the World
  – TU Vienna, Uni Maastricht, Uni Karlsruhe, Asahikawa National College of Technology, Auburn Uni, Purdue Uni, Uni of Illinois, Uni Virinia, Australian Defence Force Academy, Uni-Erlangen, Fraunhofer Uni, Uni Uta, Ohio State Uni, …

• Russian Companies and Universities
  – Russian Aluminium, EuroSib, ImpexBank
  – State University of Management, Ulianovsk Uni, Ural Tech Uni, St.Petersburg Uni, St.Petersburg Banking Inst, …

• Partners
  – ATN(France), ARC(Austria), SMS, SimNexus, OptTec, StatFit,

• About dozen of distributors
  – ARC, Simulation Modeling Services, ATN, Cosinus, Decisio Consulting, Pitotech (Taiwan), Evans & Peck (Australia), …

• Conferences
  – Winter Sim, IIE Annual Conf, System Dynamics Conf, Sim Sol, …
Thank You!

• Questions?

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