Multi-Method Modeling with AnyLogic
- System Dynamics
- Agent Based
- Discrete Event

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Workshop agenda

• About AnyLogic
• Modeling methods – quick intro
• Building a multi-method model
• Q & A
The AnyLogic Company

• We are:
  – Simulation software vendor (80%)
  – Consulting company (20%)

• Users
  – ~700 commercial and ~1000 educational organizations
  – Several thousands of users

• Applications
  – Logistics/Transportation/Supply chains
  – Healthcare (from hospital capacity planning to policies & epidemiology)
  – Manufacturing
  – Service industry
  – Military/Defense
  – Strategic planning (Market/HR/Project management/Urban/...)

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Our locations

- AnyLogic NA
  - Sales, Support, Consulting
- AnyLogic EU
  - Sales, Consulting
- DSE Consulting
- Fair Dynamics
- Blue Stallion Technologies
- ACP-IT
- SimPlan
- Tonbeller
- The AnyLogic Company
  - Headquarters, Development, Sales, Support, Consulting
- IBN
- LDM
- Beijing Carila Tech
- AtWorth
- TechSupport Mgmt
- Pitotech
- Evans & Peck
- Continente Siete
- TECHSIM
- Headquarter, Development, Sales, Support, Consulting
Selected commercial clients
The three methods in simulation modeling

- The three modeling methods are the three different viewpoints
  - the modeler can take when mapping the real world system to its image in the world of models

- **High abstraction level**
  - [minimum details]
  - macro level
  - strategic level

- **Medium abstraction level**
  - [medium details]
  - meso level
  - tactical level

- **Low abstraction level**
  - [maximum details]
  - Micro level
  - Operational level

- **System level**
  - Aggregates, global feedback loops, influences, trends...

- **Discrete Event (process based) Modeling**
  - Individual objects, exact sizes, velocities, distances, timing...
  - Discrete, disaggregated

- **Agent Based Modeling**
  - Individual-centric
  - Continuous, aggregated
Why multi-method modeling?

• Sometimes, at the beginning of the project it is not clear which abstraction level and which method should be used
  – The modeler may start with, say, a highly abstract system dynamics model and switch later on to a more detailed discrete event model

• Frequently, the problem cannot completely conform to one modeling paradigm
  – Different components may be best described by using different methods.

• Using a traditional single-method tool, the modeler inevitably
  – Either starts using workarounds (unnatural and cumbersome language constructs), or
  – Just leaves part of the problem outside the scope of the model (treats it as exogenous).

• If we want to capture business, economic, and social systems in their natural complexity and interaction, "thinking single-method" becomes a serious limitation
• **Support all three** modeling methods on a single modern object-oriented platform

• **The modeler can choose** from a wide range of abstraction levels/methods and can efficiently vary them while working on the model

• **The modeler can combine** different methods in one model
Model architectures

Agents

Agents + SD environment
(e.g., population + city infrastructure)

SD inside agent
(e.g. consumer’s individual decision making)

Agents + process model
(e.g., clients + service)

Process model inside agent
(e.g. business process in a company in a bigger supply chain model)

SD + process model
(e.g., demand + production)

DE (Process model)

Agents become entities
(e.g., patients with chronic diseases return to hospital)

and so on in any combination...
Now we will build a multi-method model in AnyLogic
Customer Satisfaction

• Modeling customer satisfaction – slippery and elusive
  – However, it is crucial to many business—particularly service—applications.

• Models do exist in a variety of methods—SD and AB primarily.
  – Assumptions of the methods and models
Specific Scenario

• This model is based on an actual model built for a client.

• This client offered a service that was subject to interruption, downtime, and similar issues. (E.g., an Internet provider)

• When the service is interrupted, the users of this service submit requests for the service to be restored. These requests are processed and the service restored on an individual level.

• The users have a varying level of Satisfaction for the service based on the service’s performance.
Model Specifics

• This model will:
  – Create User agents that interact.
  – Create their behavior and attitudes towards the service.
  – Create the process to handle service restoration requests
  – Model each user’s Satisfaction towards the Service.
  – Show the impacts of various level of request processors on the overall user market.
• The model source file *(User Satisfaction.alp)* is available in the supporting materials section
Feedbacks in the model

Utilization

Waiting time
Feedbacks inside an agent

Positive experience

Negative experience

Word of Mouth

Accumulated frustration

Accumulated WoM
Visual languages of AnyLogic

Stock & Flow Diagrams

Statecharts

Action charts

Process flowcharts
Open tool: Java “extension points”

- All objects have places to insert Java code
  - to be executed when the corresponding events occur

```java
if ( InFlow > OutFlow ) {
    V = Capacity;
    onFull();
} else {
    V = 0;
    onEmpty();
}
```

```java
stock.set_OutFlow( UnloadingRate );
```
Do I need to have programming skills?

Almost none

Some: expressions, function calls

More: expressions, function calls, statements

Classes, interfaces, inheritance, polymorphism, ...

Software development
Input and output data visualization

- Bar, stack, pie charts
- XY and time plots
- Time stack & color charts
- Histograms
- 2D Histograms
Exporting models from AnyLogic – applets

AnyLogic Model Development Environment

Remote users run models in web browsers
No need to install any software!

Export

Java applet

Publish on a web site

Send by email
Exporting models from AnyLogic – apps

AnyLogic Professional Model Development Environment

AnyLogic model runs on target machines
No need to install AnyLogic Model DE

Export

Java application

Deploy

Runtime licenses

DB
Embedding AnyLogic models into other apps

AnyLogic **Professional** Model Development Environment

Custom application is deployed on target workstations or servers

Export

Custom application

Deploy
Thank you!

• Questions?

• Links:
  – AnyLogic website: www.anylogic.com
  – AnyLogic models online: www.runthemodel.com