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Software Agents for Experimental Design in Advanced Simulation Environments

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Aims:

- To **promote use of software agents**
as assistants in simulation experimentation
- As a background:
 - To **review some (advanced) features** of agents
 - To elaborate on **types of usages of simulation**
- **To give references (but not details)**
on statistical design of simulation experiments

Plan:

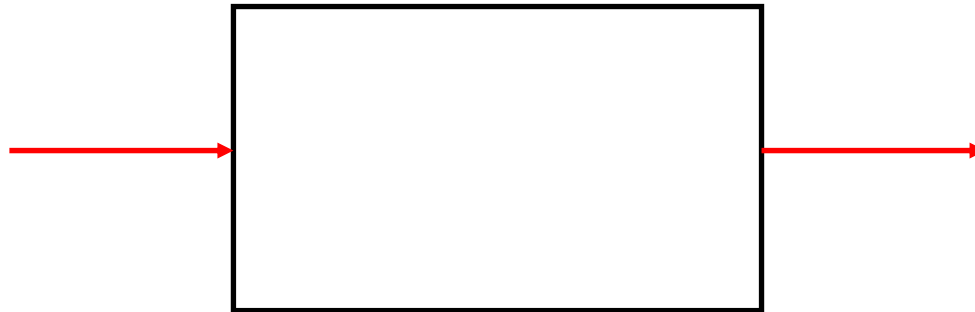
1. **Software agents - introduction**
 - Some characteristics
 - Some possible advanced features
2. **Software agents and simulation: possibilities**
3. **Assistance of agents** in experimentation:
for different types of usages of simulation

- 1.1 Agents are **software modules**
 - with **cognitive abilities** and
 - can work as **assistants** to users (and to other agents).
- They can observe their environment as well as they can affect it.
- **Cognitive abilities** include:
 - (quasi-)autonomy, perception, goal processing, goal-directed knowledge processing, motivation, reasoning, understanding, assessing, and learning.

1. Software agents:

1.2 Some possible advanced features

With respect to the **source of input** for software modules (including agents):



Input for software modules (including agents) can be generated:

Externally: exogenous input

Passive acceptance of exogenous input
(Imposed or forced input) (**Input**)

Active acceptance of exogenous input (Perceived input)

Internally: endogenous input

Input for software modules (including agents) can be generated:

Externally: exogenous input

Passive acceptance of exogenous input
(Imposed or forced input) (**Input**)

Type of access to input:

Coupling, argument passing, knowledge in a common area, message passing

Nature of input:

- **Data** (*facts*)
- *Forced* **events**
- **Sensation** (converted sensory data: analog to digital)
- *External* **goals** (*imposed goals*)

Input for software modules (including agents) can be generated:

Externally: exogenous input

Active acceptance of exogenous input (Perceived input)

-Perception (interpreted sensory data and detected events)

includes: decoding, selection (filtering), recognition, regulation

-Perceived goals (inspiration, motivation)

-Evaluated inputs

- Evaluated of inputs (acceptability)

- Evaluation of source of inputs (reliability, credibility)

Input for software modules (including agents) can be generated:

Externally: exogenous input

Passive acceptance of exogenous input
(Imposed or forced input) (**Input**)

Active acceptance of exogenous input (Perceived input)

Internally: endogenous input

Active acceptance of endogenous input

Generation of endogenous input

Input for software modules (including agents) can be generated:

Internally: endogenous input

Active acceptance of endogenous input

-Introspection

- Perceived internal facts or events; or
- Realization of lack of them (under some conditions)

Input for software modules (including agents) can be generated:

Internally: endogenous input

Generation of endogenous input

- **Anticipated facts** and/or **events** (anticipatory systems)
- Internally **generated questions**
- Internally **generated hypothesis** by:
 - Expectation-driven reasoning (forward reasoning ...)
 - Model-driven reasoning
- **Internal goals** (Internally generated goals)

2. Software agents and simulation

(Types of agent-directed simulation)

3 possibilities:

- *Agent simulation*
- *Agent-based simulation*
- *Agent-supported simulation*

2.1 Agent simulation:

- Simulation of natural or **engineered intelligent** entities represented by agents
- Mobile agents

2.2 Agent-based simulation

is a simulation study where the behavior of models are generated by using agent technology.

- May have technical merits; however, **agent simulation** is more intuitive to grasp! (since it deals with simulation of intelligent entities.)

2.3 Agent-supported simulation is simulation where agent technology is used to support simulation operations.

1. Agents are used to support **user/software interface functions**

- Front-end interface functions
 - Help, guidance, very high-level problem specification, ...
- *Back-end interface functions*
 - Explanation, interpretation, ...

2. Agents are used to support **processing of any specification** (for purposes other than model behavior generation)
 - **Agent-supported simulation quality assurance (VV&A)**

3. Agents are used to support **processing of simulation programs**

- Agent-supported **simulation program generation / integration.**
- Agent-supported **simulation program comprehension.** (for program maintenance)

3. Assistance of agents in experimentation:

The type of assistance depends on the type of usage of simulation.

Types of usages of simulation

There are **2 possibilities** with respect to **concurrency** of the operations of the real system and simulation.

- Stand-alone simulation
- On-line simulation

3.1 Stand-alone simulation:

Use of simulation independent of the real system.

There are 3 **purposes**:

- **Pure experimentation**
- **Training to enhance decision making skill**
- **Training to develop skill** in the use of hardware

3.1.1 Stand-alone simulation: Pure experimentation

Most common purpose in the use of simulation for both civilian and military applications.

This type of usage supports design, analysis, control, planning, logistic operations, simulation-based acquisition, and simulation-based evaluations of products and processes.

Stand-alone simulation: Pure experimentation

Conventional statistical design of experiments

3.1.2 Stand-alone simulation

Training to enhance decision making skill

This type of usage is done by *gaming simulation*.

In civilian applications: *business games*

In military applications: **war games, conflict management simulation, and peace support simulation**

3.1.3 Stand-alone simulation

Training to develop skill in the use of hardware

A human operator uses a virtual equipment (a simulator) to develop skills to use the equipment.

This usage corresponds

- to **simulators** (in civilian applications) and
- to **virtual simulation** (in military applications).

Stand-alone simulation

Training to develop skill in the use of hardware

3.2 On-line simulation:

Use of simulation concurrently with the real system.

There are 3 goals of usages:

- To support the operations of the real system
- To foster on-line diagnosis
- To augment reality

3.2 1 On-line simulation

To support the operations of the real system

Simulation can provide **predictive displays**.

3.2.2 On-line simulation

To foster on-line diagnosis

- Run real system and simulation concurrently and compare their behaviors.
- A **difference** may indicate a **malfunction** of the real system.

3.2.3 On-line simulation

To augment reality

In **augmented (or mixed) reality simulation**, real and virtual entities (that can be people or equipment) and the environment can exist at the same time.

Hence, operations can take place in a richer *augmented reality environment*.

Reality is a special case of simulation!

We have seen:

1. Software agents - introduction

Some characteristics

Some possible advanced features: **Types of inputs**

2. Software agents and simulation: possibilities

3. Assistance of agents in experimentation:

for different types of usages of simulation