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BEHAVIORAL ANTICIPATION IN AGENT SIMULATION

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Aim

- Our **aim** is to develop a *paradigm* and *modeling methodologies* for **conflict management simulation.**

- Along this line, we formulated and continue working on *multimodels* and *multisimulations* as well as on *fuzzy agents with dynamic personality*.

- **Multimodel** and **multisimulation** formalisms are suggested as a promising approach to deal with uncertainty, as well as multi-phased problems where the nature of the problem changes as the simulation unfolds.

Some Questions

- Can we have a view of **anticipation** consistent with **causality**?

- What are the **types of inputs** that a simulation model (or a software module in general) can have?

- (**as a special type of input**) is **perception** important?

- Can we consider **anticipation a special type of** *perception*?

- What is **behaviorally anticipatory simulation**?

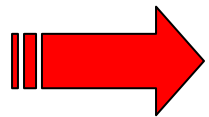- What is **behaviorally anticipatory agent simulation**?

Plan
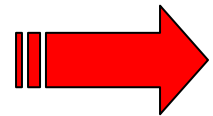
1. Background – *Need* for a new simulation paradigm

2. *Anticipation*

3. **Perception** (& anticipation as a type of perception)

4. *Types of inputs* of a simulation model (or a software module in general)

5. Behaviorally anticipatory **agent simulation**

   as a new simulation paradigm

Need for a new simulation paradigm

- Proper paradigm and methodologies are needed to conceive realistic models of complex conflict systems where the nature of the problem changes as the simulation unfolds due to uncertainty in various phases of the problem.
- New simulation methodologies can help us perceive, conceive, and foresee conflicting situations to ideally avoid them and –if they are inevitable– to resolve them.

- In conflict situations the decisions are influenced by: personality, mood, cultural background as well as by *perceptions* and *anticipations.*

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Anticipation

- Anticipation is an important characteristic of intelligence.

- Pro-active behavior requires anticipatory abilities.

  (Without anticipation a system can only be reactive.)

A seminal work on anticipatory systems is the one written by Rosen*

* Rosen R. (1985) Anticipatory Systems – Philosophical, Mathematical and Methodological Foundations. Pergamon Press, New York.

"Strictly speaking, an anticipatory system is one in which present change of state **depends** upon future circumstances, rather than merely on the present or past.

As such, anticipation has routinely been excluded from any kind of systematic study, on the grounds that *it violates the causal foundation* on which all of theoretical science must rest. …"

* Rosen R. (1985) Anticipatory Systems – Philosophical, Mathematical and Methodological Foundations.

"Thus, the concept of a system with an **internal predictive model** seemed to offer a way to study anticipatory systems in a scientifically rigorous way."

Rosen

A source* for 12 definitions of anticipation:

with the following warning: "The following 12 definitions, or descriptions, of anticipation should be understood as **working hypotheses**. It is hoped and expected that the knowledge community of those interested in anticipation will eventually refine these definitions and suggest new ones **in order to facilitate a better understanding of what anticipation is** and its importance for the survival of living systems"
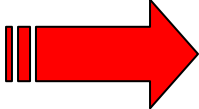
* Special Interest Group in Anticipatory Systems.

(Berkeley Initiative in Soft Computing)

Our view:

- Systems whose next state depend on current image(s) of future state –instead of future values of the states– can be properly named **behaviorally anticipatory systems**.

- Behaviorally anticipatory systems are consistent with **principle of causality** where cause has to precede effect.

  (Furthermore, there can be more then one current image of the future state of a system which leads to **multimodeling** and **multisimulation**.)

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Perception

- The way we perceive reality affects our feelings, decisions, and actions.

- Since Plato's allegory of the cave that he explained in the Republic, it is well known that perception is very important.

- There are **two types of perception**: **external** and **internal perceptions**.

- "*External* or *sensory perception*, tells us about the world outside our bodies. Using our senses of sight, hearing, touch, smell, and taste, we discover colors, sounds, textures, etc. of the world at large.

- *Internal perception* tells us what's going on in our bodies. We can sense where our limbs are, whether we're sitting or standing; we can also sense whether we are hungry, or tired, and so forth."

(Wikipedia).

- Both types of **perceptions** can involve thought processes (i.e., **knowledge processing**)

- *Introspection* is the detailed mental self-examination of feelings, thoughts, and motives.

- "In psychology and the cognitive sciences, **perception** is the process of acquiring, interpreting, selecting, and organizing sensory information.

- Methods of studying perception range from essentially biological or physiological approaches, through psychological approaches to the often abstract 'thought-experiments' of mental philosophy."   (Wikipedia)
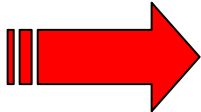
Categories of Perception:

|	Current images of	
	Past or current state	**Future state**
others (people and/or events)	**Perceived image** of others and events	**Behavioral anticipation** of others and events
self (decision maker(s), supporters, followers; and/or events related with one's own side)	**Perceived image** of self and/or events related with one's own side	**Behavioral anticipation** of self and/or events related with one's own side

Perceptions –including anticipations– are **subjective** and are prone to *biases* and *influences*.

- Some biases may stem from lack of relevant knowledge.

- Others may be induced by others by influencing decisions.

- *Unsymmetric information*, *misinformation*, and *disinformation* are part of techniques used to influence the perceptions.

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Types of inputs of a simulation model
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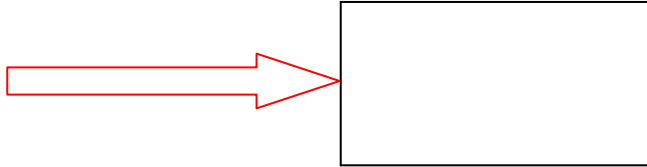
Two types of inputs:

- **External inputs:** (as an age-old concept)

  (Externally generated inputs, exogenous inputs)

- **Internal inputs: (as a relatively new concept)**

  (Internally generated inputs, endogenous inputs)

Mode of Input	Type of External Inputs

Passive acceptance of exogenous input (imposed or forced input)	**Nature of input:**
	- **Data**, facts
	- Forced (external) **events**
	- **Sensation** (converted sensory data:
	    from analog to digital
	    single or multi sensor – sensor fusion)
	- **External goals** (imposed goals)
	Types of access to input: coupling, argument passing, knowledge in a common area, message passing, broadcasting,

Active perception of exogenous input (perceived input)	**Perception** (interpreted sensory data and selected events) (possibly anticipated) - includes: decoding, selection (filtering), recognition, regulation **Perceived goals** **Evaluated inputs** - evaluation of inputs (acceptability) - evaluation of source(s) of inputs (reliability, credibility)

Mode of Input	Type of Internal Inputs
Perception of internal inputs	**Introspection (perceived** internal facts, events; or realization of lack of them)
Generation of internal inputs	**Anticipated facts** and/or **events** (anticipatory systems) **Deliberation** of past facts and/or events (deliberative systems)
Types of internal inputs	**Internally generated questions** **Internally generated hypotheses** by: - Expectation-driven reasoning (Forward reasoning, or Bottom up reasoning, or Data-driven reasoning) - Model-driven reasoning **Internal goals** (internally generated goals)

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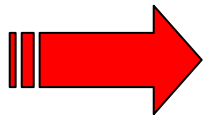
Behaviorally anticipatory simulation & agents

- Simulations where behaviorally anticipatory system models are used can be named **behaviorally anticipatory simulations**.

- **Perception ability** is a required characteristic of agents.

- Hence, **agents** can be designed to perceive current state of self and others. They can also be designed to create **current image(s)** of **future state(s).**

A major difference between traditional deliberative agents and an anticipatory agent:

- An **anticipatory agent** makes guesses / predictions / forecasts about the future state of the environment to guide its behavior.

- **Conventional deliberative agents** make their decisions based on the observed conditions within the current context.

Agents in behaviorally anticipatory simulation

- **Anticipation** requires observing and collecting measurements of interest and making inferences about plausible future states.

An **anticipatory system**

- should contain a model of the environmental context that it interacts with. This model needs to be predictive.

- should also reason from observed events, inquire about information, share assertions, generate hypotheses, check plausibility and establish confidence, adapt, and rationalize from present data and generalize disparate elements to provide incremental improvements in confidence estimates about future projections.

Basic Components for Anticipatory Agents:
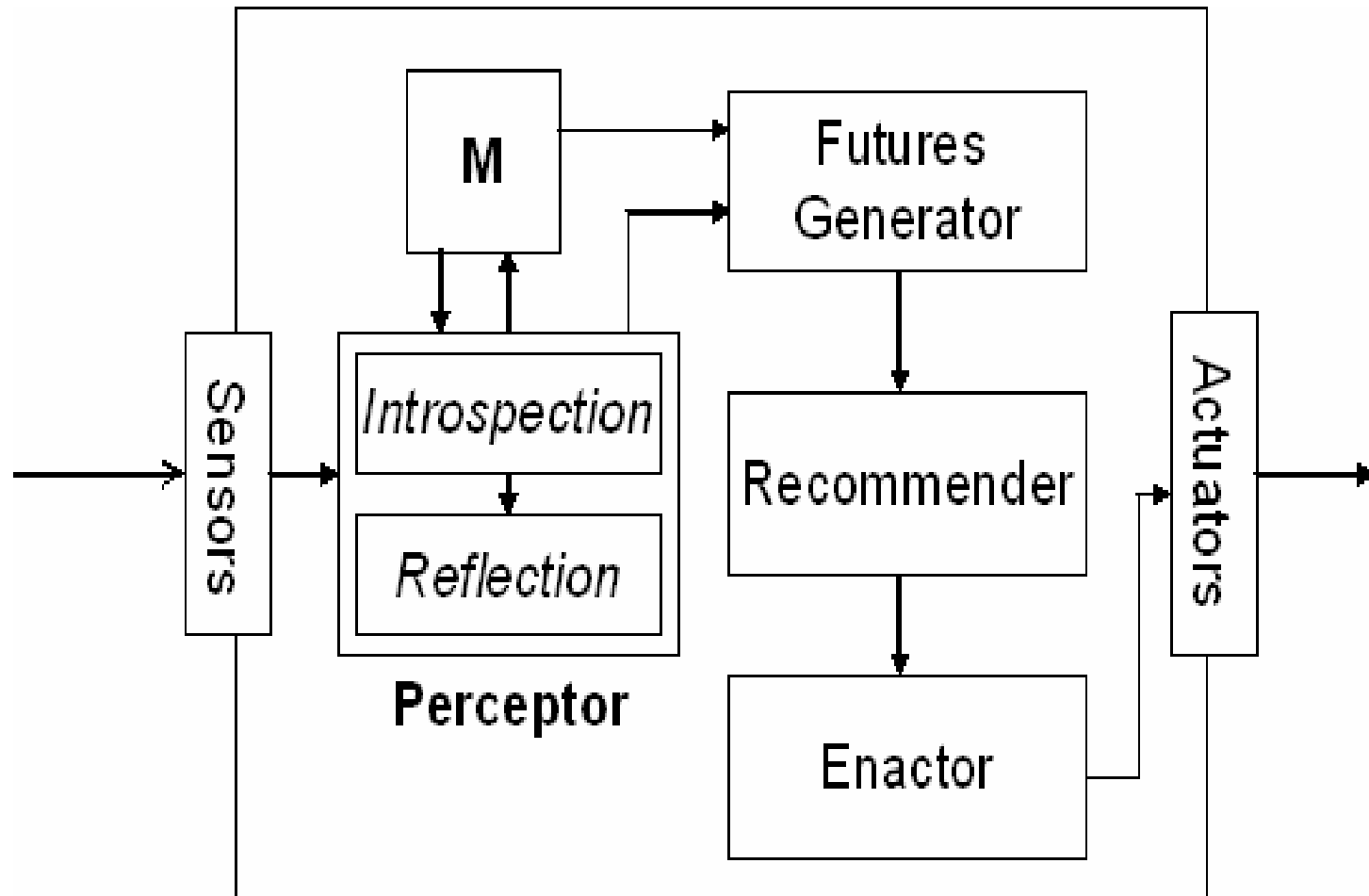
The major issue underlying **multisimulation** is the need for run-time switching of models based on interpretation of emergent, potentially unforeseen, conditions to facilitate dynamic run-time simulation composition and simultaneous experimentation with multiple plausible models.

Online model recommenders augmented with anticipatory simulation capabilities and future generators will have capability to interface with the simulation kernel and the underlying operating environment to make recommendations as needed to explore the solution space.

We Have Seen

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