Introduction to Intelligent Agents for Business Professionals

Employing artificial intelligence in the creation and use of digital financial reports

By Charles Hoffman, CPA

Overview

- Definition of artificial intelligence
- Implementing artificial intelligence using intelligent agent technology
- Definition of an intelligent agent
- Categories of Agent Function
- Categories of Agent Sophistication
- Understanding How agents work
- Agents Working Together: Multi-agent Systems
- Why is the Important?

Introduction to Intelligent Agents, Retrieved July 24, 2016;
http://www.mind.ilstu.edu/curriculum/ants_nasa/intelligent_agents.php

Artificial Intelligence

- **Artificial intelligence** is the automation of activities that we associate with human thinking and activities such as decision making, problem solving, learning and so on.
- **Expert systems** is a branch of artificial intelligence. Expert systems are computer programs that are built to mimic human behavior and knowledge.

Introduction to Artificial Intelligence Terminology, Retrieved July 24, 2016;
http://xbrl.squarespace.com/journal/2016/7/21/introduction-to-artificial-intelligence-terminology.html

Understanding the Components of an Expert System, Retrieved July 24, 2016;
http://xbrl.squarespace.com/journal/2016/5/24/understanding-the-components-of-an-expert-system.html

Intelligent Agent

- An ***intelligent agent*** is software that assists people and acts on their behalf. Intelligent agents work by allowing people to:
    - **delegate work** that they could have done to the agent software.
    - **perform repetitive tasks**,
    - **remember things** you forgot,
    - intelligently find, filter and **summarize complex information**,
    - **customize** information to your preferences,
    - **learn from you** and even make recommendations to you.

Hanh Tran & Thaovy Tran, *Intelligent Agent*, Retrieved July 24, 2016;
http://groups.engin.umd.umich.edu/CIS/course.des/cis479/projects/agent/Intelligent_agent.html

Agent

- An agent is an entity capable of **sensing** the **state** of its **environment** and **acting** upon it based on a set of specified **rules**. An agent performs specific tasks on behalf of another. In the case of software, an agent is a software program.
- The main difference between a software agent and an ordinary program is that a software agent is **autonomous**; that is, it must operate without direct intervention of humans or others.

Thermostat is a Simple Agent

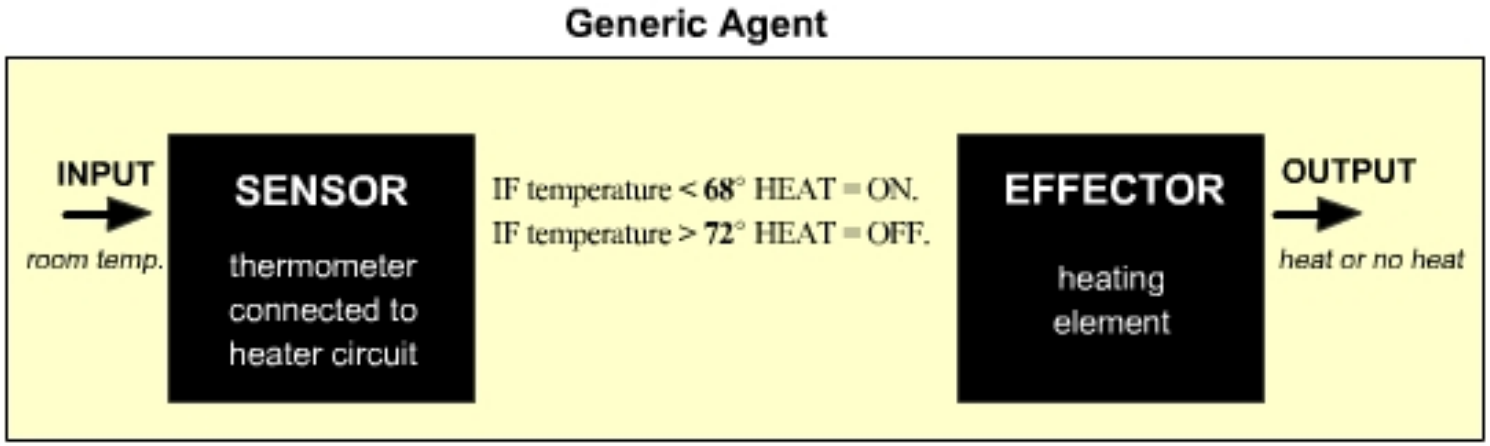

Fig. 1: Thermostat agent

Generic agent: An agent is anything that perceives an environment through sensors and acts or reacts upon the environment through effectors (see Russel and Norvig, p. 31).

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Categories of Agent Functionality

- **Important distinctions between agents:**
  - **Rational agent:** A rational agent is one that acts so as to achieve the best outcome or, when there's uncertainty, the best expected outcome. Rationality as used here refers to following the rules of logical reasoning, making correct inferences, and selecting the appropriate action that will lead to achieving the desired goal.
  - **Autonomous agent**: An autonomous agent is a system situated within and a part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future.
- **Categories of agents according to their functionality**:
  - **Reactive agent**: A reactive agent is capable of maintaining an ongoing interaction with the environment and responding in a timely fashion to changes that occur in it.
  - **Pro-active agent**: A pro-active agent is capable of taking the initiative; not driven solely by events, but capable of generating goals and acting rationally to achieve them.
  - **Deliberative agent**: A deliberative agent symbolically represents knowledge and makes use of mental notions such as beliefs, intentions, desires, choices and so on. (This is implemented using a belief-desire-intension model.)
  - **Hybrid agent**: A hybrid agent is one that mixes some of all the different architectures.

C# - Applying AI to a Multi-Agent 'Mini-Basketball' Game, Retrieved July 24, 2016; https://msdn.microsoft.com/en-us/magazine/mt736456.aspx

Categories of Agent Sophistication

- **Least sophisticated to most sophisticated agent functionality:**
  - **Generic agent**: An agent is anything that perceives an environment through sensors and acts or reacts upon the environment through effectors.
  - **Simple reflex agent**: A simple reflex agent looks up what it should do from a list of rules in response to its perception to the environment.
  - **Model-based reflex agent**: A model-based reflex agent is the same thing as a simple reflex agent except that a model-based reflex agent has a model of how the environment evolves.
  - **Goal-based agent**: A goal-based agent has a goal or set of goals that it actively pursues in accordance with an agenda(so this type of agent is proactive, not just reactive). A goal based agent has a representation of the current state of the environment and how that environment works. The agent pursues policies or goals that may not be immediately attainable. And so, goal based agents do not live merely in the moment. These agents consider different scenarios before acting on their environments, to see which action will probably attain a goal. This consideration of different scenarios is called search and planning.
  - **Utility-based agent**: A utility-based agent is a more sophisticated type of goal-based agent that also rates each possible scenario to see how well it achieves certain criteria with regard to production of the good outcome, therefore it is more adaptive. A utility measure is applied to the different possible actions that can be performed in the environment. The utility-based agent will rate each scenario to see how well it achieves certain criteria with regard to the production of a good outcome. Things like the probability of success, the resources needed to execute the scenario, the importance of the goal to be achieved, the time it will take, might all be factored in to the utility function calculations.

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Learning Versus Non-learning Agents

- **Learning agent**: A learning agent is one that requires some training to perform well, adapts its current behavior based on previous experiences and evolves over time.
- **Non-learning agent**: A non-learning agent is one that doesn't evolve or relate to past experiences and is hard coded and independent of its programming.

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Terminology

- **Agent**: An agent is an entity capable of sensing its environment and acting upon it. An agent performs specific tasks on behalf of another. In the case of software, an agent is a software program.
  - **Environment**: environment in which the agent operates; description of the state of affairs that change over time as real world situations do.
  - **Sensing capabilities**: capability of the agent to understand its environment; determines the sort of data the agent is capable of receiving as input.
  - **Percept**: A percept refers to the agent's perceptual inputs at any given moment.
  - **Percept sequence**: The percept sequence represents the complete sequence of percepts the agent has sensed or perceived during his lifetime.
  - **State**: current conditions of the environment. (Or, a projected conditions of the environment based on actions taken.
  - **Actions**: change in the environment brought about by the agent, requiring the agent to update its model of the world, which in turn may cause the agent to change its immediate intention.
  - **Condition-action rules**: A formal and implementable expression of some business user requirement. Includes definitions of terms, structural assertions, action assertions, and derivations.
  - **Desires**: overall policies or goals of the agent.
  - **Action selection architecture**: an agent decides what to due next by consulting both its internal state, the state of the world, and its current goal; then the agent uses decision making procedures to select an action.

Categories of Business Rules, Retrieved July 24, 2016; http://xbrl.squarespace.com/journal/2016/7/19/categories-of-business-rules-first-pass.html

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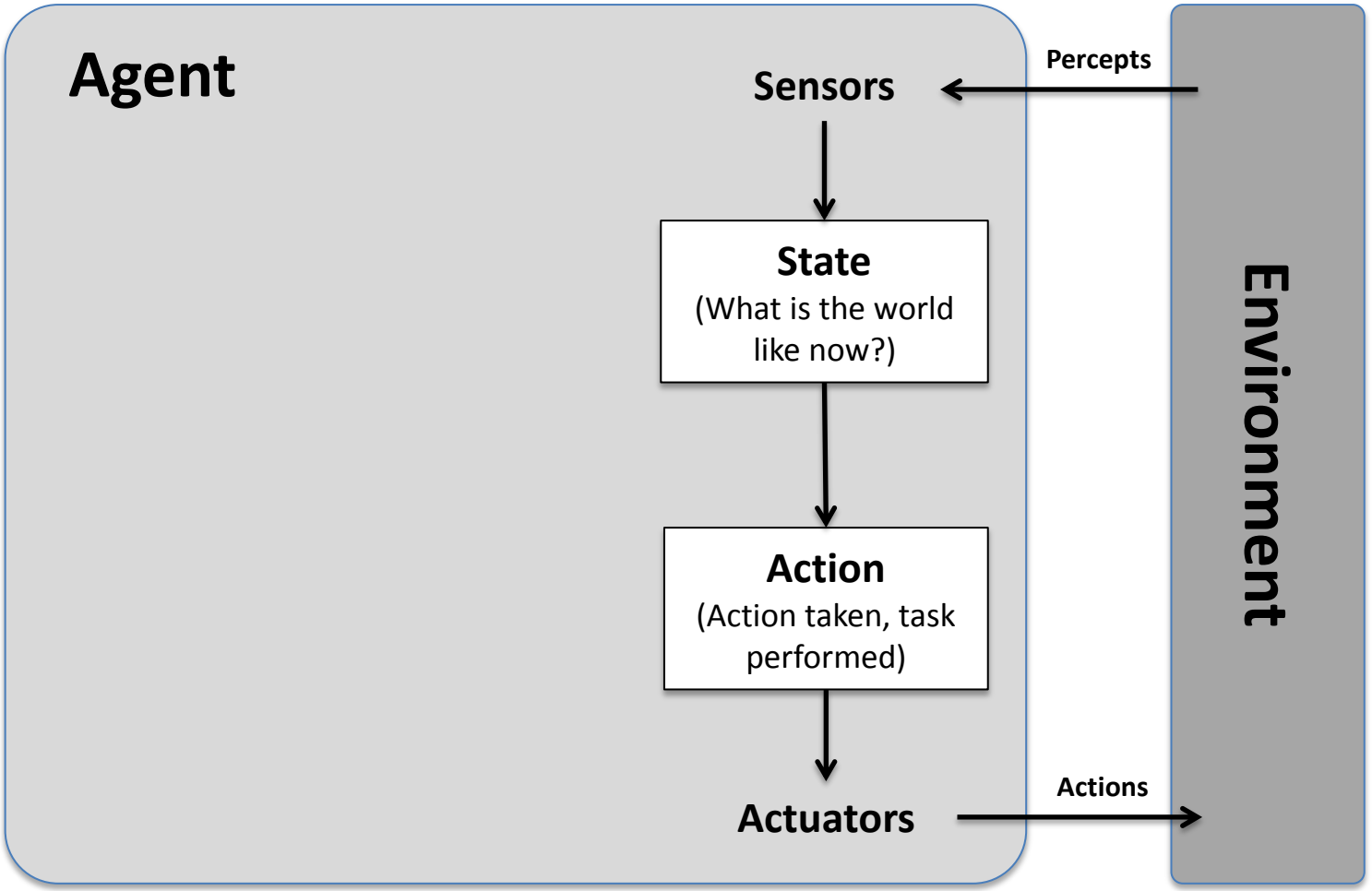
Generic Agent



Wikipedia, *Intelligent Agent,* Retrieved July 24, 2016; https://en.wikipedia.org/wiki/Intelligent_agent

Basic Control Loop of an Autonomous Agent

While true

1. observe the world (**environment**);
2. update internal world model (**state**);
3. deliberate about what intention to achieve (**goal**);
4. use means/ends reasoning to get a plan for the intention (**condition-action rules**)
5. execute the plan (**action**)

End while

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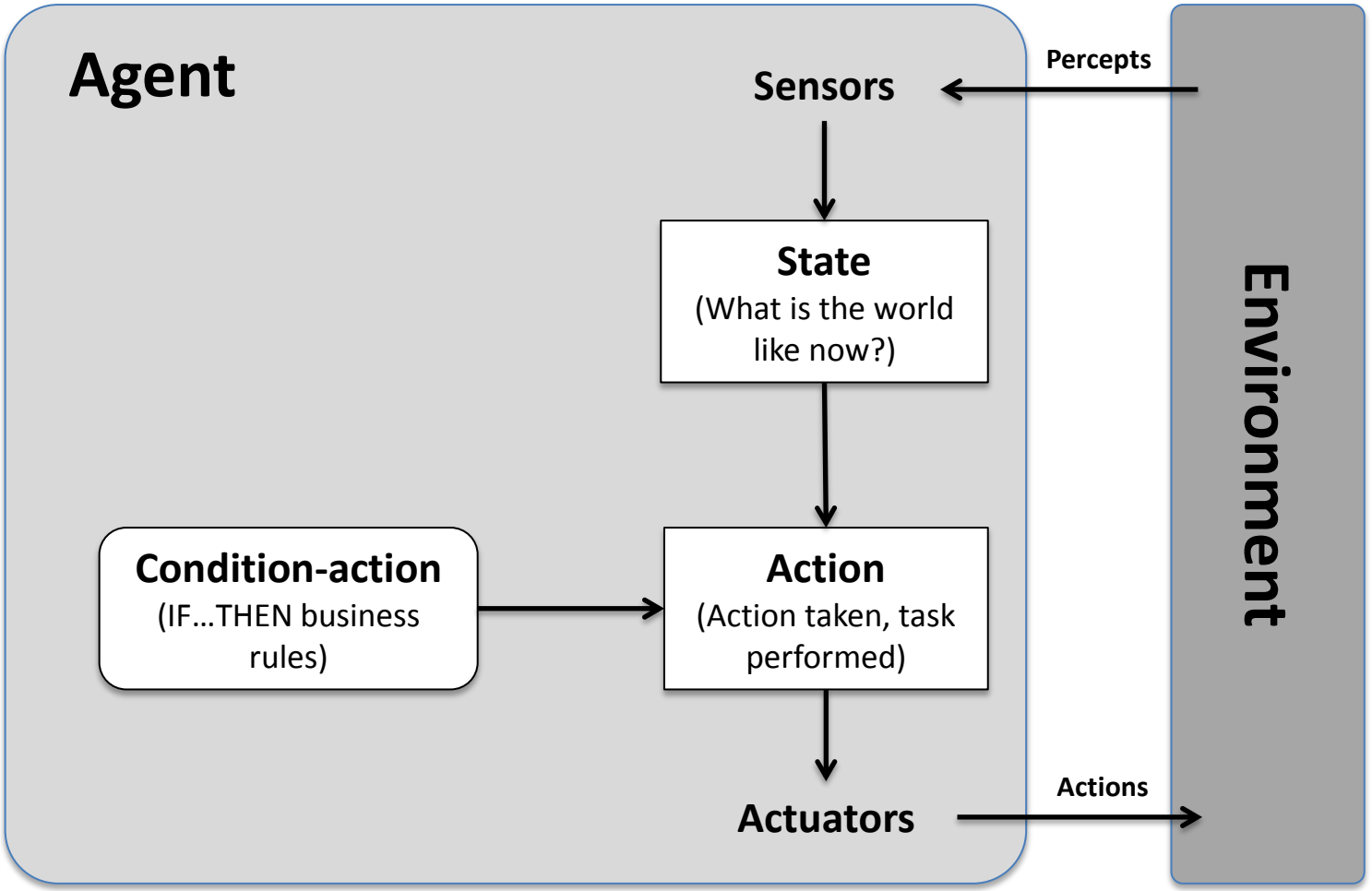
Simple Reflex Agent

- A simple reflex agent looks up what it should do from a **list of rules** in response to its perception to the environment.
- Algorithm of simple reflex agent:
  - Function Simple-Reflex-Agent (percept) returns action
    - **persistent**: *rules*, a set of condition-action rules
    - *state* <<<< Interpret-Input (*percept*)
    - *rule* <<<< (Rule-Match (*state*, *rules*)
    - *action* <<<< *rule*.Action
    - **return** *action*

Hugo Larochelle*, Intelligence Artificielle*, Retrieved July 24, 2016; https://www.youtube.com/watch?v=TUHAVbaBLlg

Simple Reflex Agent



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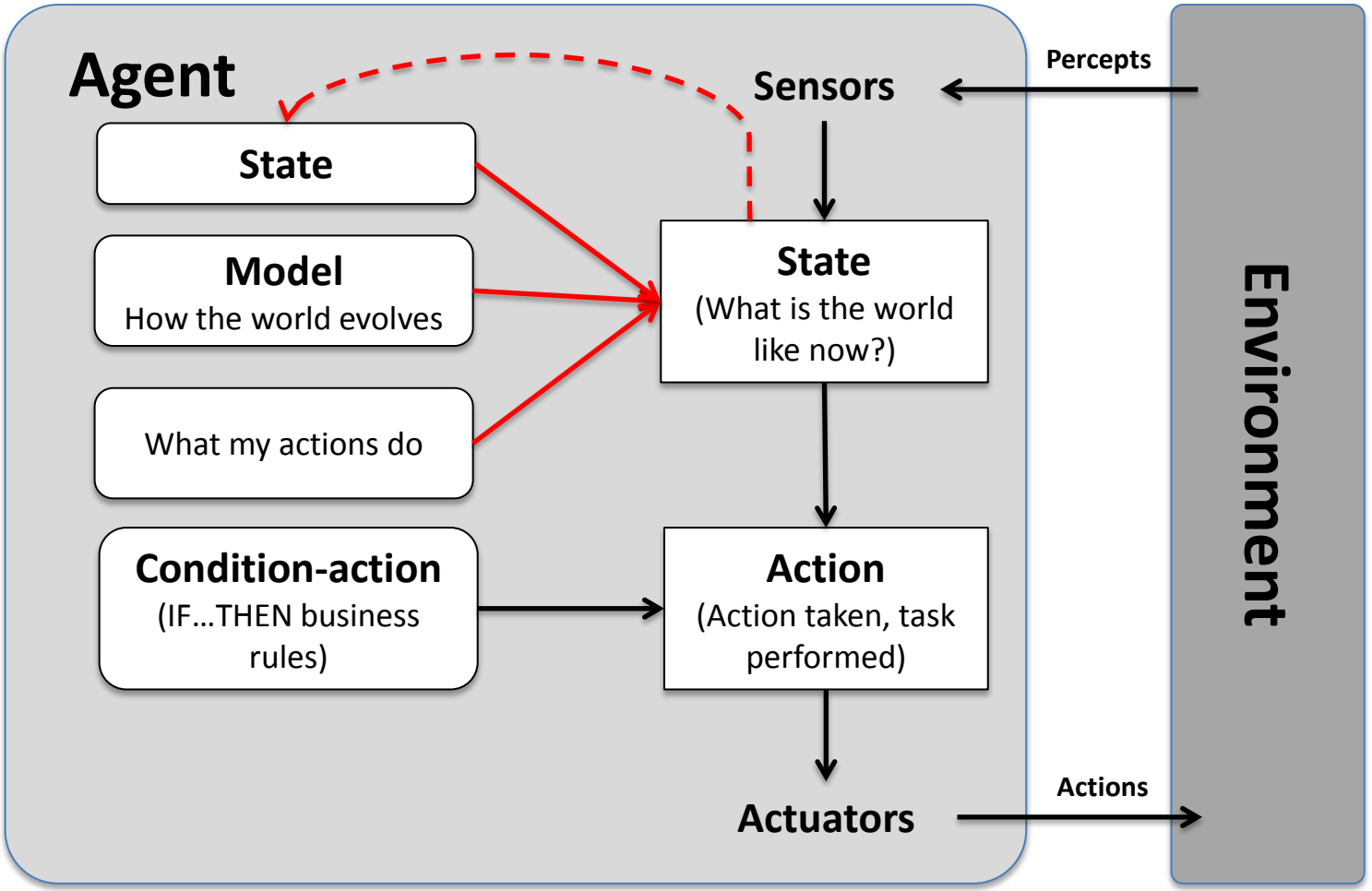
Model-based Reflex Agent

- Same as a simple reflex agent
- Adds additional functionality of a model of the environment.

Hugo Larochelle*, Intelligence Artificielle*, Retrieved July 24, 2016; https://www.youtube.com/watch?v=TUHAVbaBLlg

Model-based Reflex Agent



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Goal-based Agent

- Same as a model-based reflex agent
- Adds additional functionality of wondering what the environment will be like if a specific action is taken, evaluating if that state is desirable or undesirable given specific goals and desires given that state.

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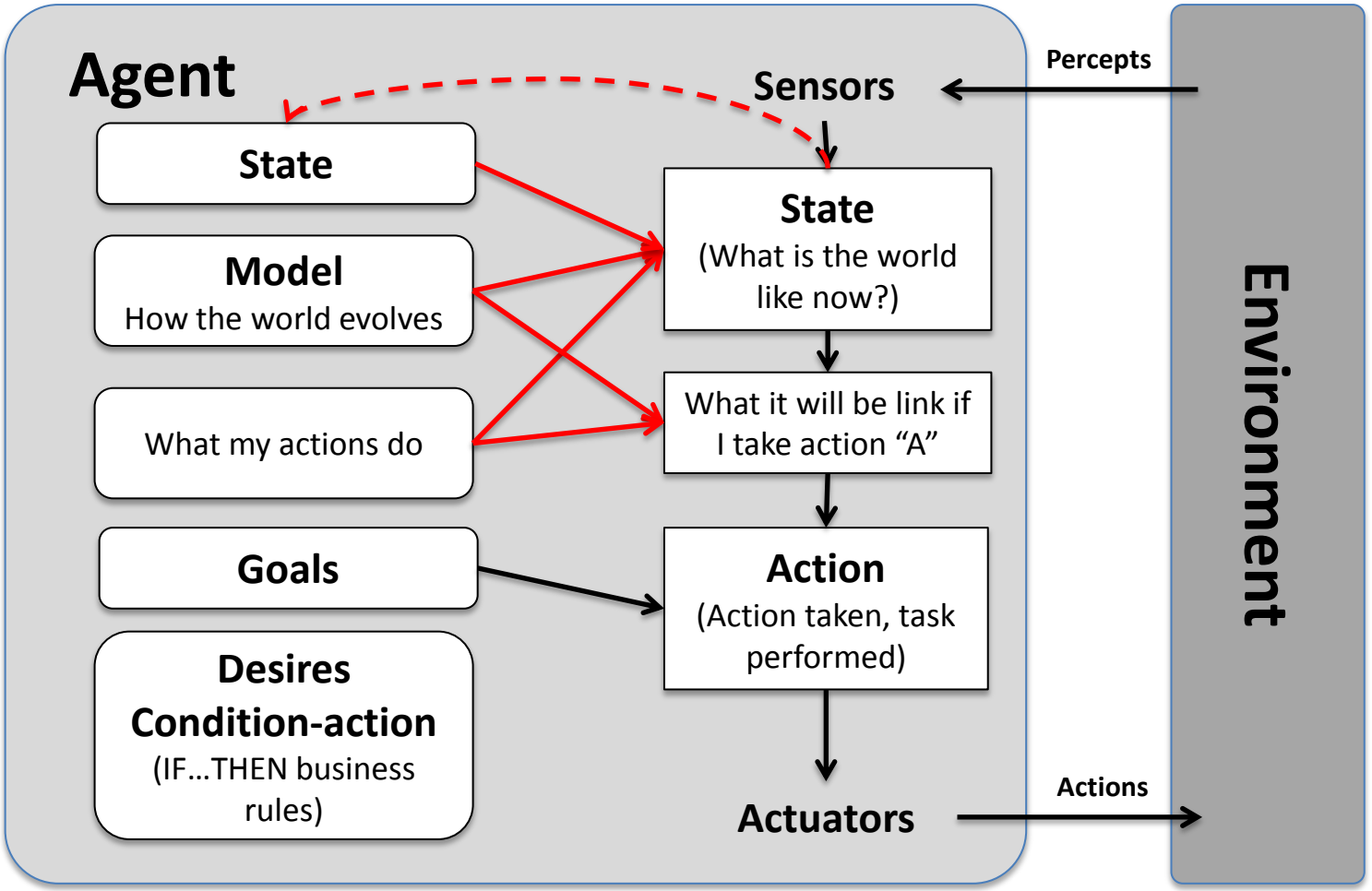
Goal-based Agent



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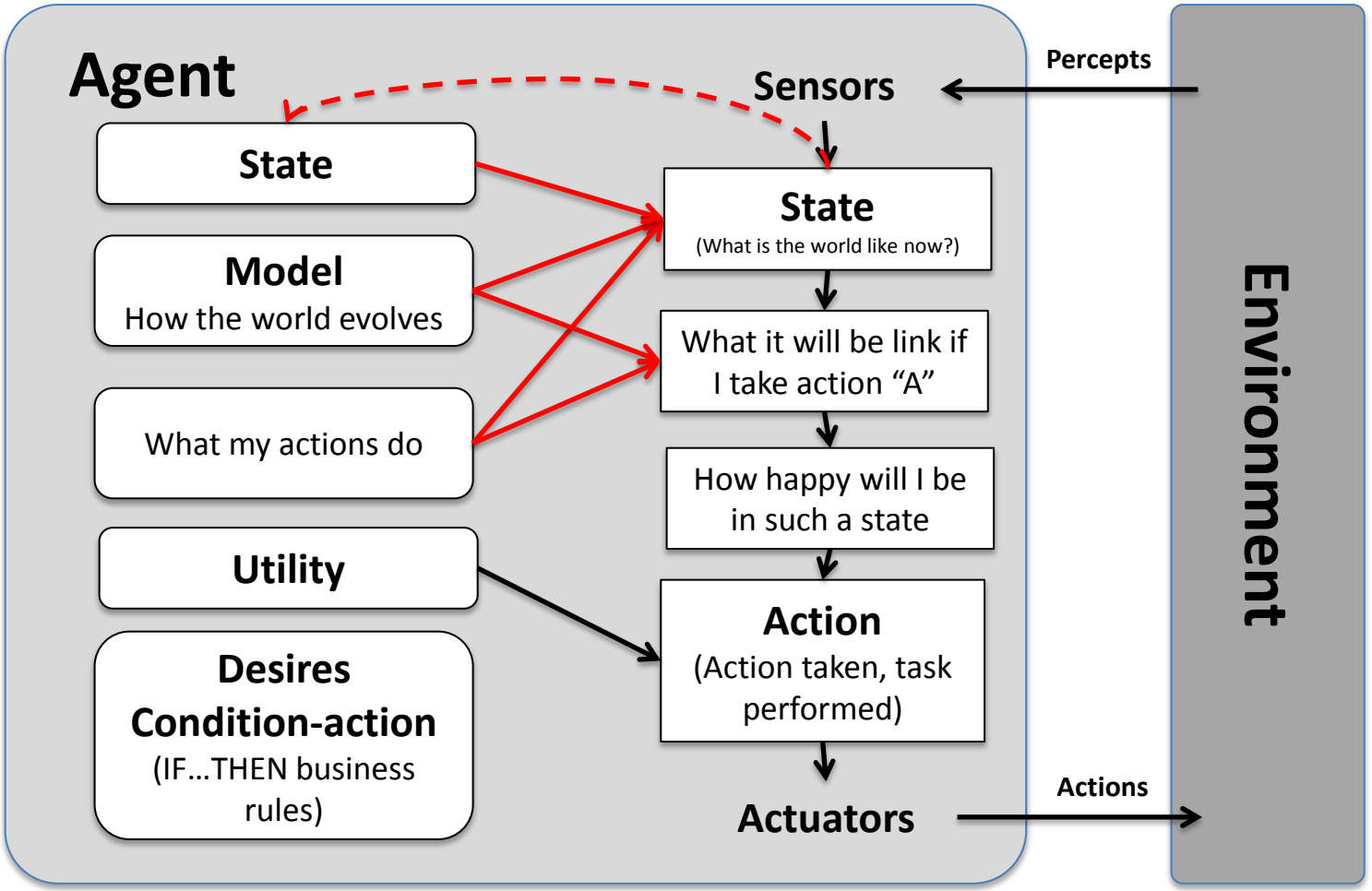
Utility-based Agent

- Same as a goal-based reflex agent
- Adds additional functionality of wondering what the environment will be like if a specific action is taken, evaluating if that state is desirable or undesirable given specific goals and desires given that state, and evaluating how happy the agent will be within that state.

Hugo Larochelle, *Intelligence Artificielle*, Retrieved July 24, 2016; https://www.youtube.com/watch?v=TUHAVbaBLlg

Utility-based Agent



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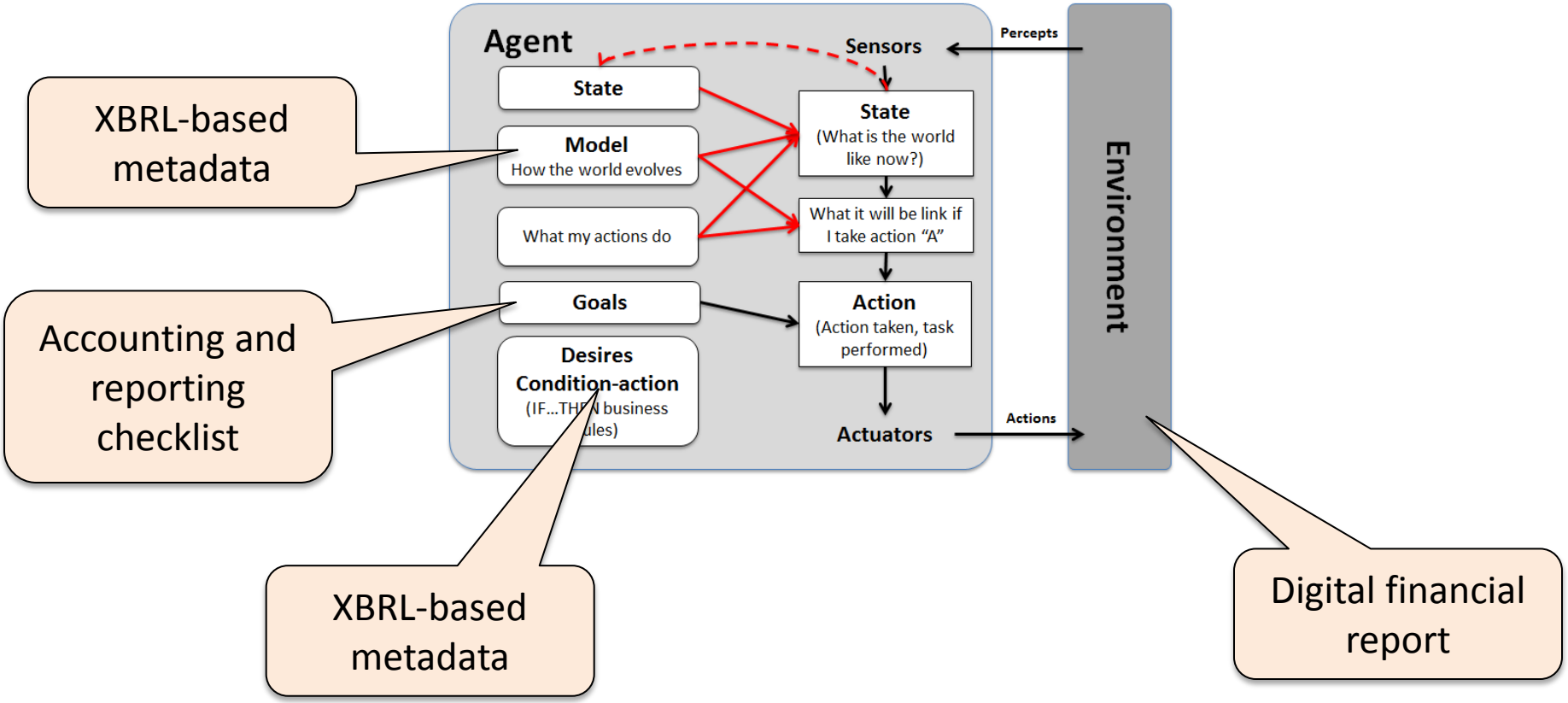
Agents Working Together: Multi-agent Systems

- **Multi-agent system**: When an agent coexists in an environment with other agents, perhaps collaborating or competing with them, the system is considered a multi-agent system.
- **Coalition**: A coalition is any subset of agents in the environment.
- **Strategy**: A strategy is a function that receives the current state of the environment and outputs the action to be executed by a coalition.
- **Blackboard**: A blackboard structure is a communication form that consists of a shared resource divided into different areas of the environment where agents can read or write any significant information for their actions.
- **Coordination**: Coordination is essential in mult-agent system because it provides coherency to the system behavior and contributes to achieving team or coalition goals.
- **Cooperation**: Cooperation is necessary as a result of complementary skills and the interdependency present among agent actions and the inevitability of satisfying some success criteria.
- **Competition**: Another possible model is that in which the agents are self-motivated or self-interested agents because each agent has its own goals and might enter into competition with the other agents in the system to achieve these goals. In this sense, competition might refer to accomplishing or distributing certain tasks.
- **Negotiation**: Negotiation might be seen as the process of identifying interactions based on communication and reasoning regarding the state and intentions of other agents.

C# - Applying AI to a Multi-Agent 'Mini-Basketball' Game, Retrieved July 24, 2016; https://msdn.microsoft.com/en-us/magazine/mt736456.aspx

Global Standard Rational, Deliberative, Non-learning, Goal-based Agents



Automating Accounting and Reporting Checklists, Retrieved July 24, 2016; http://xbrl.squarespace.com/journal/2016/5/5/automating-accounting-and-reporting-checklists.html

Benefits Offered by an Expert System, Retrieved July 24, 2016; http://xbrl.squarespace.com/journal/2016/5/30/understanding-the-benefits-offered-by-expert-systems.html

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