Multi-Agent Systems

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Multi Agent Systems

Agent

- Characteristics
- Architecture
- Advantages
- Typology
- Communication
- Objects
- Expert Systems
- MAS

- **An agent is a computational entity that:**
  - Acts on behalf of other entities in an autonomous fashion
  - Performs its actions with some level of proactivity and/or reactiveness
  - Exhibits properties like learning, cooperation, and mobility to a certain extent

- **Software agents (often simply termed agents) are software systems that freely fit the aforementioned criteria and can principally be described as inhabiting computers and networks, assisting users with computer-based tasks.**

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Autonomy

Capability to work autonomously without human intervention. For this purpose, they are supposed to possess necessary skills and enriched with required resources.

Co-operation

In order to complete the tasks, agents must interact with users, the environment, and other agents.

Learning

Agents should be able to learn from the entities with which they interact to complete their tasks.

Reactivity

Agents perceive their environment and respond in a timely fashion to changes enforced by the environment.

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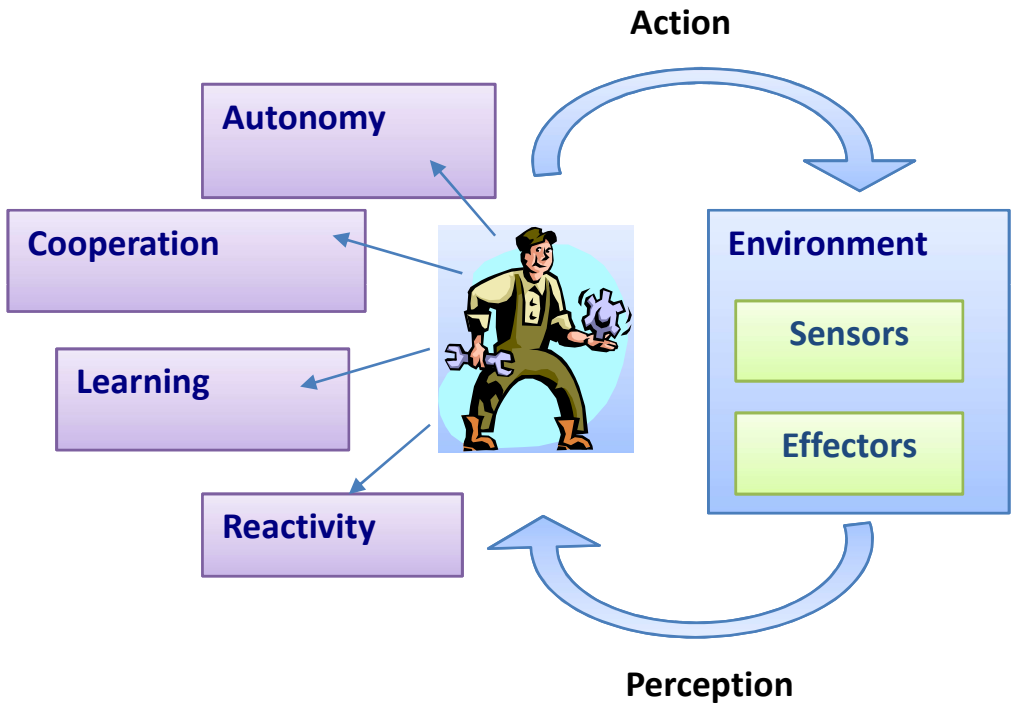

Figure 1: Architecture of an agent

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- They can be used to solve large, complex problems.
- They allow interconnection and interoperation of multiple existing legacy systems.
- They provide solutions to problems where information resources, expertise, and the problem itself are widely distributed.
- They enhance modularity, speed, reliability, flexibility, and reusability in problem solving.
- They lead to research into other issues—for example, understanding interactions among human societies.

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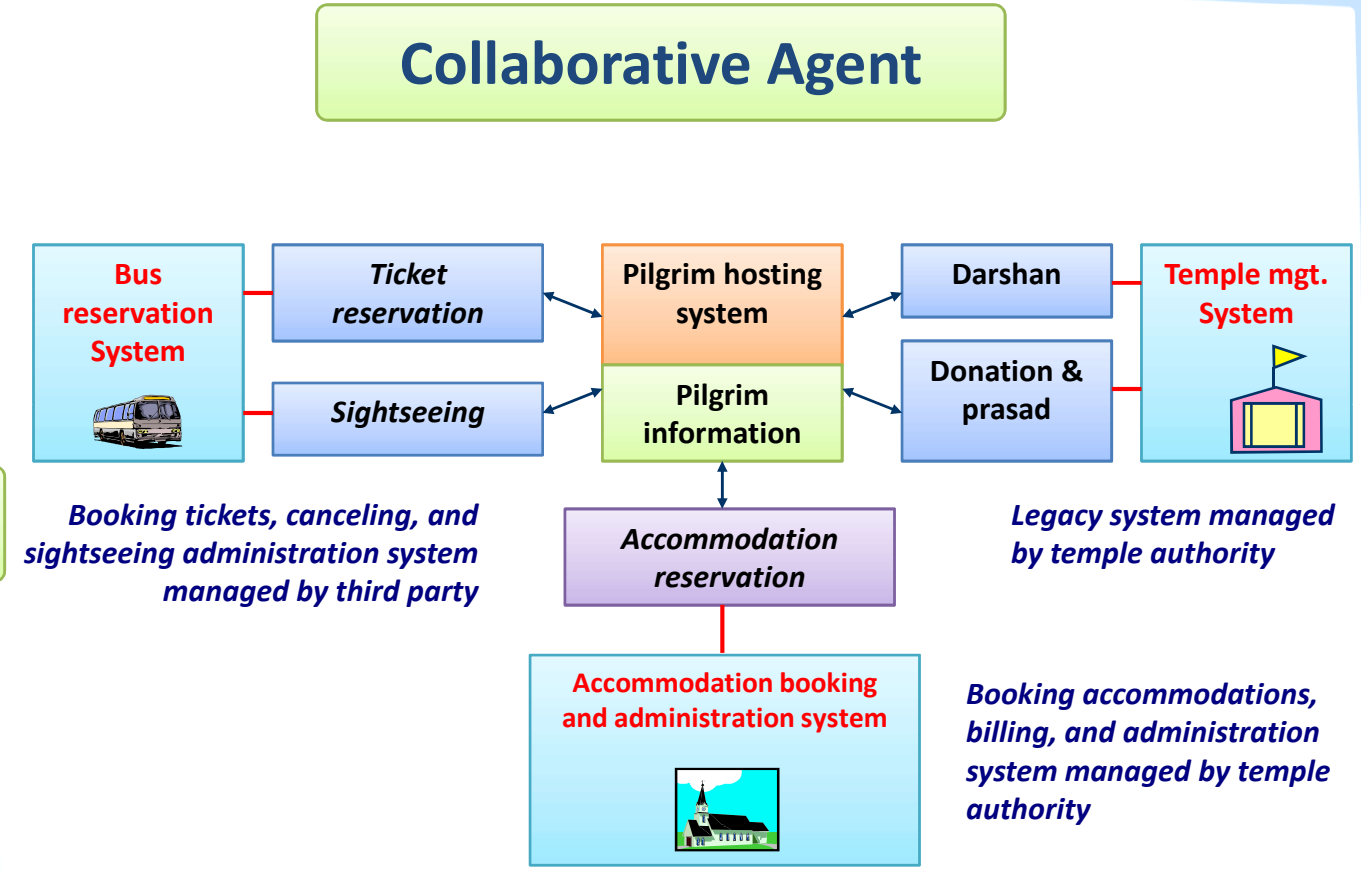

Figure 2: An example of a collaborative agent

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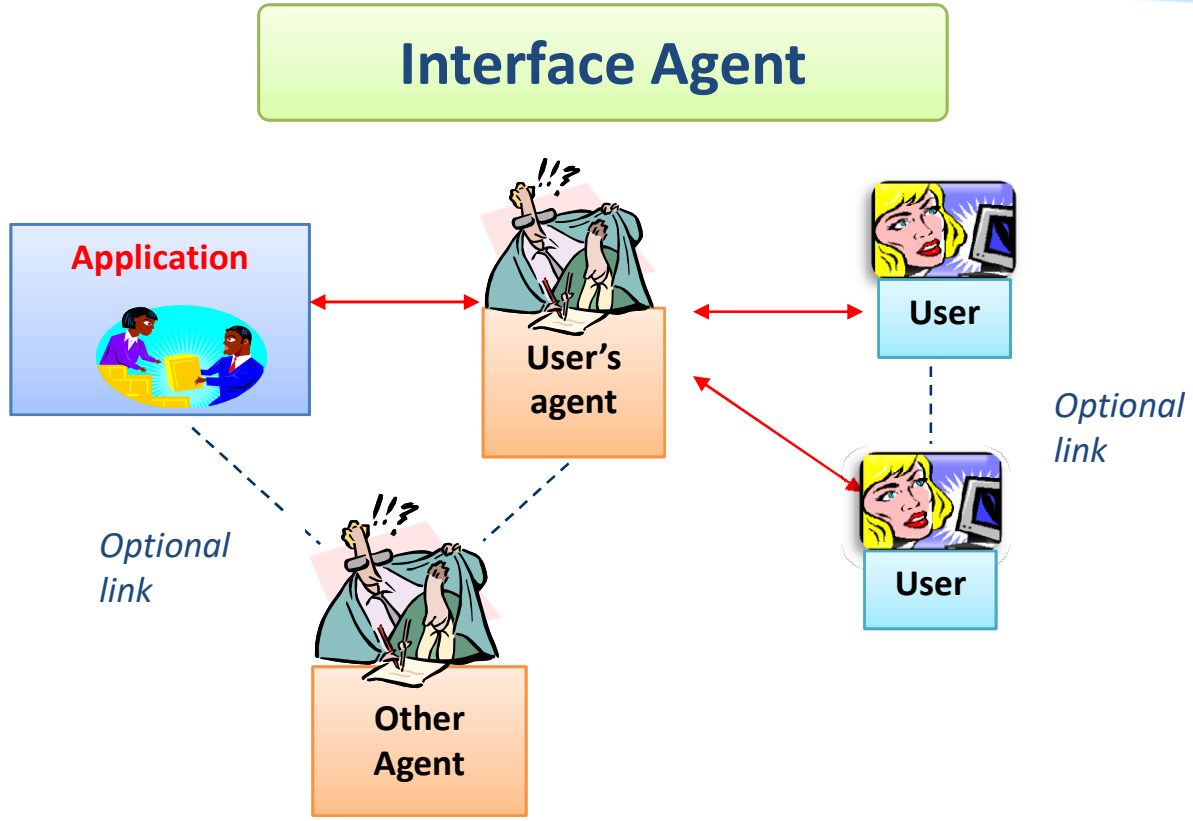

Figure 3: An example of an interface agent

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Mobile Agent

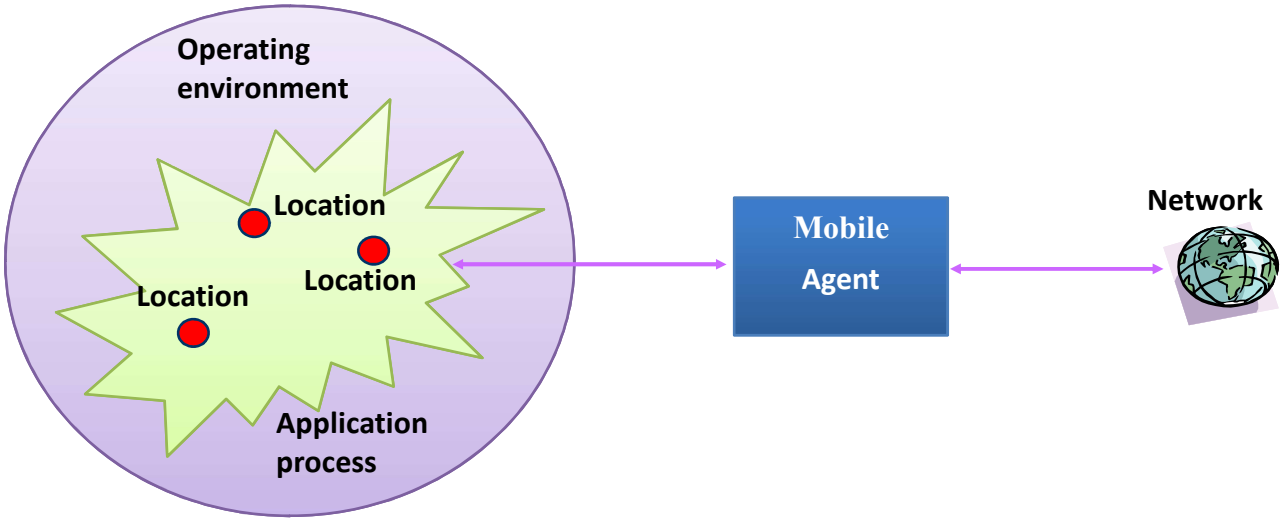

Figure 4: Workflow for a mobile agent

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Information Agent

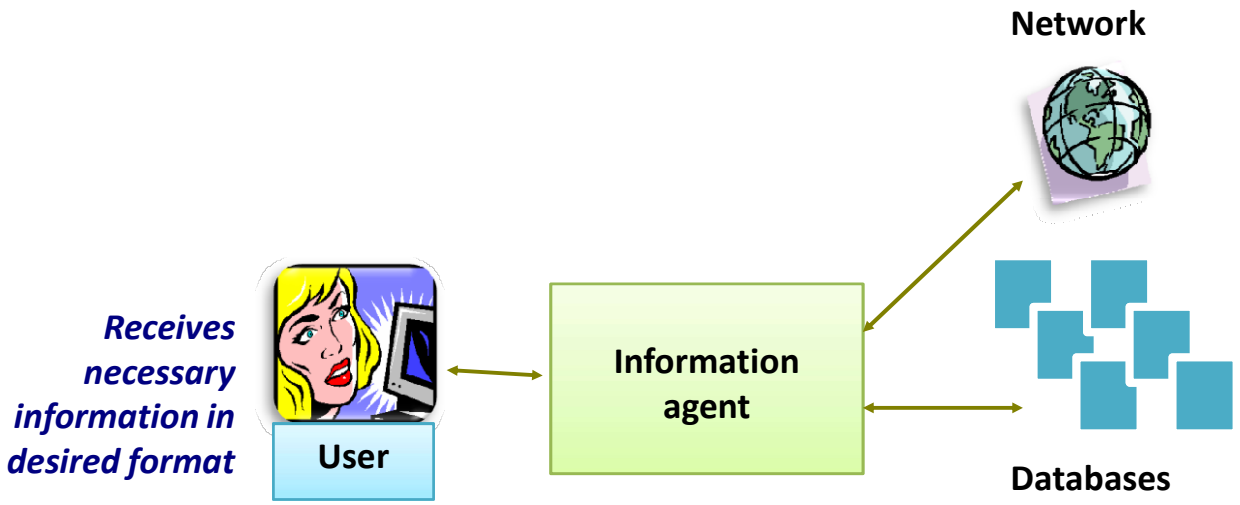

Figure 5: Workflow for an information agent

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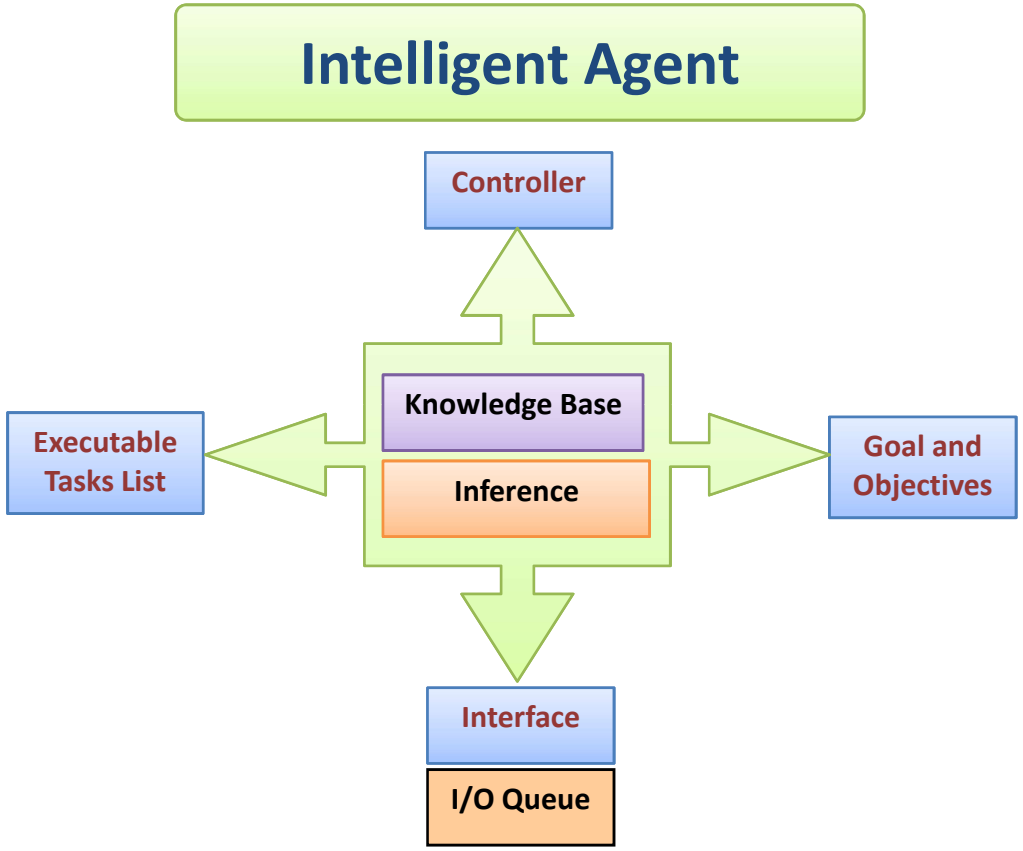

Figure 6: Structure of an intelligent agent

Multi Agent Systems

Hybrid Agent

- A hybrid agent combines two or more agent categories.
- For example, an agent facilitating effective information searching from large databases and providing communication through a well-designed, natural-language interface is a hybrid agent because it encompasses the methodologies of an information agent as well as an interface agent.
- Such hybrid agents can be placed at the upper level of the agent hierarchy and hence, become application specific.

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Knowledge Query and Manipulation Language (KQML) Block

(A query about the price of a share)

```
(ask-one
:content “price (Infosys, [?price])”
:receiver stock-server
:language LPROLOG
:ontology NYSE-TICKS)

(ask-all
:content "price(Infosys, [?price, ?time])"
:receiver stock-server
:language standard_prolog
:ontology NYSE-TICKS)
```

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- **Multi Agent System**

- A multi agent system is comprised of several intelligent agents working together toward a goal or completion of a task.
- It is a loosely coupled network of problem-solving entities that work together to find answers to problems that are beyond the capacity of any individual problem-solving entity.
- This system is called for when complex problems require the services of multiple agents with diverse capabilities and needs.
- Besides multiple agents, a multi agent system (MAS) does the following:
  - Provides an environment for the agents
  - Sets the relationships between the entities
  - Provides a platform for a set of operations that can be performed by the agents

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- **MAS Architecture**

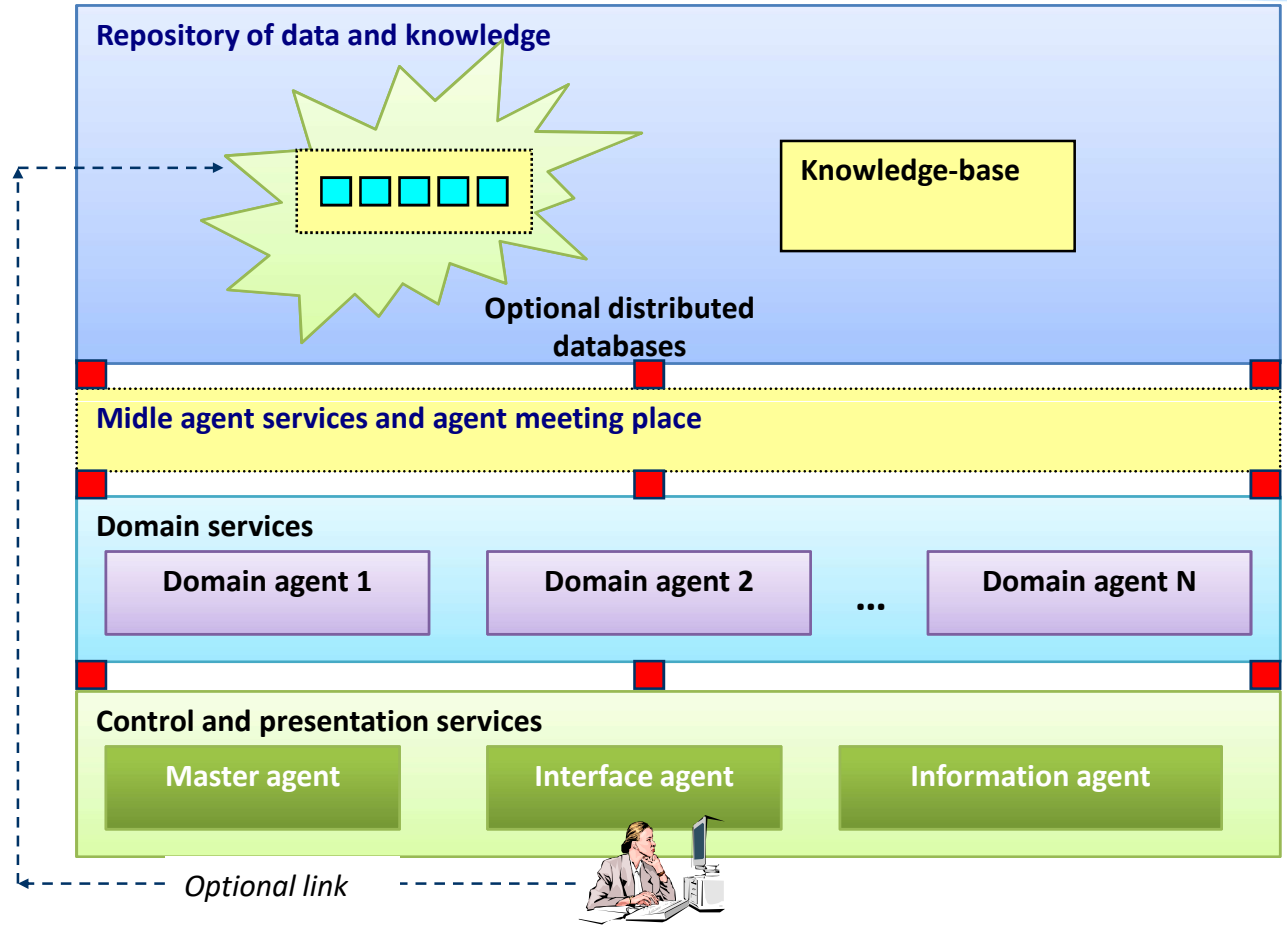

Figure 7: Layered architecture of generic multi agent system

Multi Agent Systems

Research Directions

- Intelligent agent designs
- Learning in a multi agent system
- Analysis and design methodology for multi agent system development
- Agent communication, specification, and/or programming languages
- Agent protocols and standards
- Agents for a Semantic Web for automatic processing of data
- Agents for information retrieval and data mining
- Supporting agents for Web services and service-oriented computing
- Agents serving as middleware for grid computing
- Knowledge management agents for an organization
- Agents for E-commerce
- Query and interface agent for business applications
- Agents for a personal assistance system

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Recommended Text Book

"Knowledge-based systems"

Rajendra Akerkar and Priti Srinivas Sajja
Jones & Bartlett Publishers, Sudbury, MA, USA