CM30174 + CM50206 Intelligent Agents

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Paper Overview

"Towards an environment interface standard for agent platforms"

Tristan M. Behrens, Koen V. Hindriks, Jürgen Dix

Annals of Mathematics and Artificial Intelligence (2011), 61:261–295.

Problem Overview

Issues:

- There are many Agent Programming Languages (*APL*s)
  - 2APL
  - GOAL
  - JADEX
  - *Jason*
- Multiple Environments
  - Agent Competitions
  - Unreal Tournament 2004
- How can we connect / compare these components?
  - Connections: TCP/IP, RMI, wrapping Java code, JNI
  - Comparisons: we can't.

Goals

- Implementing an environment interface standard would:
  - make already working environments widely available
  - facilitate distribution of current and future environments
  - allow direct comparison of APL platforms
  - enable the develpment of a fully heterogeneous multi-agent system (*MAS*)
- In order to be accepted as a standard, it should:
  - Provide an interface that is as *generic as possible*
  - *Reuse as much as possible* from existing interfaces
- Therefore the objective is to:

  > "*Design and develop an environment interface standard (EIS) that facilitates connecting agents programmed in various agent platforms to environments.*"

Goals (contd.)

- No assumptions need to be made about the internal structure or behaviour of any of the environments or entities
- However, the agent platform needs to support a minimal agent-based abstraction:
  Actions and percepts are treated as first-class entities.
- The standard is based on:
  - A meta-model for agent-environment interaction
  - A set of principles that encode useful constraints for implementing the standard
- The meta-model arises from a study of existing APLs, and avoids restricting existing approaches
- The princples are based on the requirements of the project, and observed best practices among existing work

Principles

1. *Portability*: .jar files are suggested but not required, for easy exchange of environments between platforms
2. *Generality*: The *EIS* should impose minimal restrictions on the platform or environments. Assumptions about the agents or the environments should be avoided
3. *Separation of concerns*: Agents are *separated* from the environment
4. *Unified connections*: The *EIS* should facilitate communications between agents and the environment(s)
5. *Standards for actions/percepts/events/etc.*: The *EIS* should provide a convention for communicataing about concepts, without restricting any existing approach
6. *Support for heterogeneity*: The interface standard needs to facilitate heterogeneity - connections between an environment and agents of multiple types

Related Work

There are a number of other projects that support generic connections between agents and an environment:

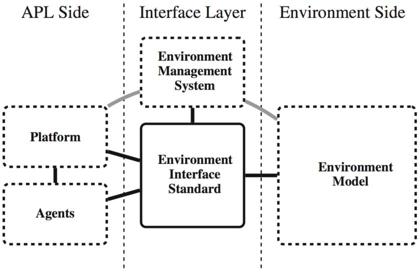
- A&A: a generic paradigm for modeling environments. Implemented in the distributed middleware CArtAgO
- Soar is an architecture for knowledge-rich agents capable of intelligent behavior in dynamic environments
- GameBots and Pogamut are a pair of projects designed to allow agents to control bots in UT2004. A number of other projects use them as an initial base
    - pyPOSH aims to use Behaviour Oriented Design agents
    - the ACT-R cognitive architecture uses GameBots
- The high level architecture (HLA) is a federated architecture for distributed simulations
- The *UtJackInterface* defines another UT2004 interface from scratch - none of these approaches facilitate reuse

Existing Agent Programming Languages

- A number of existing APLs indicate common and uncommon features that the meta-model must support
  - 2APL
  - GOAL
  - JADEX
  - *Jason*
- Though each APL is designed to fulfil similar purposes, they vary in implementation details
  - 2APL provides a common format for exchanging data between agents and the environment
  - GOAL uses a scheduler to manage execution of agents
  - JADEX store environments as beliefs of the agents
  - *Jason* provides spohisticated abstract environments
- The different APLs have differing degrees of environment management functionality available

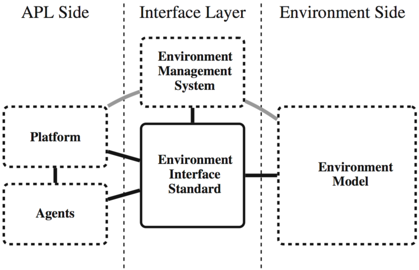
Existing Environments

Meta-model



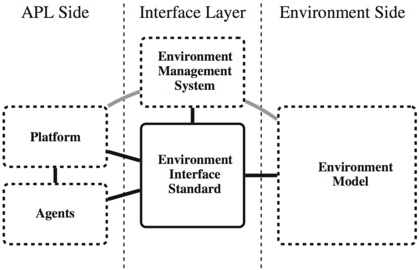
1. *Agent*: able to perceive its environment through sensors and act upon that environment through effectors.

Meta-model



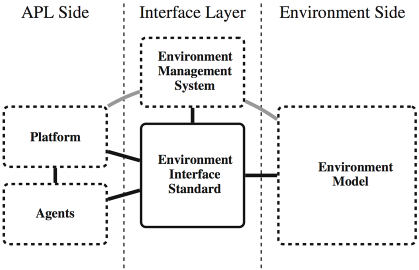
1. *Agent*
2. *Environment model*: contains *controllable entities* that give agents effective and sensory presence in the environment.

Meta-model



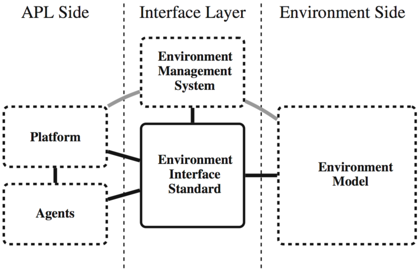
1. *Agent*
2. *Environment model*
3. *Platform*: instantiates and executes agents; connects agents to the environment and controllable entities.

Meta-model



1. *Agent*
2. *Environment model*
3. *Platform*
4. *Environment management system (EMS)*: provides actions for managing an environment, such as setup, pause and reset.

Meta-model

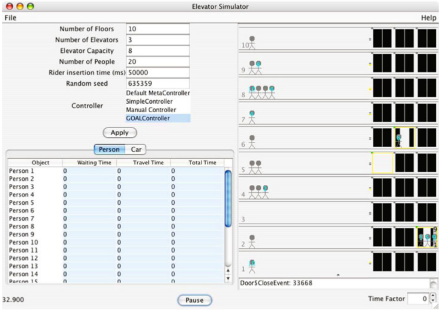


1. *Agent*
2. *Environment model*
3. *Platform*
4. *Environment management system (EMS)*
5. *Environment interface standard (EIS)*: the layer that connects the platform, the EMS, and the agents to the environment(s).

Interface Immediate Language

Implementation

Case Study: Elevator



Number of Floors: 10
Number of Elevators: 3
Elevator Capacity: 8
Number of People: 20
Rider insertion time (ms): 50000
Random seed: 635359
Controller: Default MetaController / SimpleController / Manual Controller / GOALController (selected)

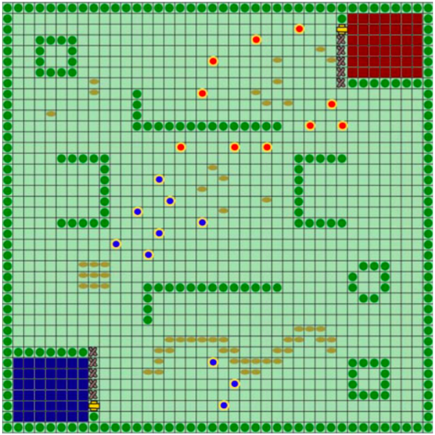
Object	Waiting Time	Travel Time	Total Time
Person 1	0	0	0
Person 2	0	0	0
Person 3	0	0	0
Person 4	0	0	0
Person 5	0	0	0
Person 6	0	0	0
Person 7	0	0	0
Person 8	0	0	0
Person 9	0	0	0
Person 10	0	0	0
Person 11	0	0	0
Person 12	0	0	0
Person 13	0	0	0
Person 14	0	0	0
Person 15	0	0	0

DoorSCloseEvent: 33668

32.900

Time Factor 0

Case Study: Agent Contest



Case Study: Unreal Tournament

Summary

standard functionality is provided by the interface implementation itself agent platforms that support the interface can connect to any environment that implements the interface