

# Intelligent Virtual Environments for Agents

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# Overall Aim and Hypothesis

## Aim

To allow agents to participate in a richer, more complex and more intelligent way in their environment in the framework of an explainable and plausible cognitive model.

## Hypothesis

- Current agents are limited by their environmental interaction.
- We can attempt to change this by improving the way in which agents interact with their environment.

## Herb Simon (1969)

*"Complexity of an ant's behaviour walking along a beach has more to do with the complexity of the environment rather than an inherent internal complexity of the ant itself."*

# Definitions: Agent

Russell and Norvig *Artificial Intelligence* – pg 31, 1995

*"An agent is anything that can be viewed as perceiving its **environment** through sensors and acting upon that **environment** through effectors."*

d'Inverno and Luck *Understanding Agent Systems* – pg 2, 2001

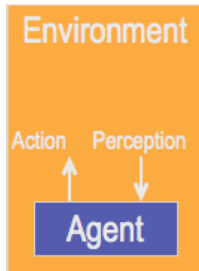
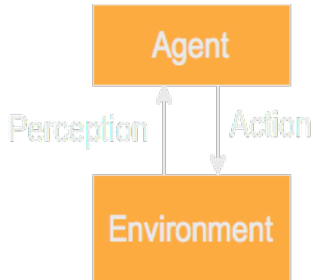
*"... agents have been proposed as **situated** and **embedded** problem solvers that are capable of functioning effectively and efficiently in a complex **environment**."*

Wooldridge *Multiagent Systems* - pg 29, 1999 - editor G. Weiss

*"An agent is a computer system that is **situated** in some **environment** and that is capable of autonomous **action** in this environment in order to meet its design objectives."*

# Definition: Environment

- Agents can be situated in different types of environments:
  - Real
  - Virtual
- We are interested in synthetic (spatial and temporal) environments that are representations of real or fictional worlds:
  - Simulations
  - Interactive Entertainment



# Requirement for Virtual Environments

# Definition: Intelligent

- ...as in Artificial Intelligence.
- Including perception, reasoning and action.
- Components of a software system that contains "smarts":
  - Components which use traditional AI algorithms
  - Components which are models of human cognitive processes.
- Research in multi-agent systems suggest that these types of processes belong in the agent.

# Designing Intelligent Information Systems

- Limited representation of the environment in classical artificial intelligence.
- Then agents came along... agent could live in, perceive, reason and act in their environment.
- Many agents became quite large and heavyweight and exhibit properties of classical AI systems.
- "Intelligence" belongs in the agent?



The software design spectrum – where to put the intelligence in an intelligent system?

# Real Environments: Augmentation

Augmenting real environments for a purpose

- Head Up Displays and Helmet Mounted Sights
- The Road and Traffic System



# Classical AI vs Situated Cognition

## Classical AI vs Situated Cognition

<b>Classical View of Mind</b>	<b>Situated Cognition</b>
Individual	Social
Rational	Embodied
Abstract	Concrete
Detached	Located
General	Specific

It is claimed that agents are situated given that they can perceive and act in an environment. However:

- Most agent designs don't have the characteristics espoused by the situated cognition community.
- Most agent designs ignore the environment and are detached (reasoning is separate from perception and action).

# Ideas for Designing Virtual Environments

- Situated Cognition (Clancy, Suchman)
- Cognitive Systems (Hutchence) – Boeing 747 Example
- Ecological Psychology (Gibson) – Affordances
- Labelling of Entities in the Environment by:
  - Name, Category
  - Affordance
  - Relationships
  - Purpose or Intention of Agens

Consider a motor racing simulation/game...

# Motor Racing Simulation: The Scenario

# Environmental Representation Options

- Agent driving a virtual car around a virtual racing track...
- The environment consists of a track, other cars, obstacles, team-mates, marshals, the pits, pit-crew, team-boss, spectators.
- What are our virtual environment representation options?
  - Intelligent Agents
  - Intelligent Environments
  - "Intelligence" is shared between agents and environments.

# Intelligent Agent: Low Level Perception

- One extreme is to make the agent do everything starting with low level perception
- Agent needs to perceive geometry, colour, lighting, material, motion and then recognise high level objects such as roads etc.
- **Advantage:** agent is portable to many types of environments.
- **Disadvantage:** computationally expensive, a lot of engineering is spent designing low level processing.

# An Environment Labelled for an Agent

# Driver Agent: Rounding a Corner

# Labels, Names, Categories and Plans

- We can label things in different ways.
  - As cars, roads, buildings, traffic lights.
  - As opponents, pedestrians and other drivers, or everything is an obstacle to the agent winning!
- Parts of the environment can be labelled. For example, consider labelling a corner:
  - As a left/right tight turn
  - With prescription: *"Take this corner at 60-75 km/h, in 3rd gear in a gentle left hand turn."*



# Environmental Labelling by Category



Screenshot from Falcon 4: F-16 Flight Simulator Game

# Relationships in the Environment

- Can the agent driver query the environment about relationships?
  - *"Who is in front of me?"*
  - *"Who is behind me?"*
- How about more complex relationships that are dynamic?
  - *"Do I have an overtaking opportunity?"*
- Relationships between team members.

# Affordances in Crazy Taxi

- Premise is to pickup fare paying passengers.
- The quickest route to the destination, the more money the passenger will pay.
- Passengers tip extra for crazy stunts and tricks.
- Certain buildings afford picking up passengers.
- Objects in the the city afford doing stunts (like ramps for jumps).
- Different road surfaces afford going faster.
- All sorts of things afford being a short-cut.



# An Environment Labelled for an Agent

# Summary

- Agent interactions with the environment aren't as interesting or complicated as they could be.
- Virtual environments and agents can be designed (unlike real environments).
- Exploring the "agent-environment" interface allows us to investigate alternative ways of intelligent agents in virtual environments.
- We can use ideas from cognitive science to ground our designs in theory of situated cognition.
- This will help us build environments in which agents and humans can interact.