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 Intellligence – 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**."*

Wooldrdige *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 View of Mind	Situated Cognition
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)
- Cognitve 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 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

Relationships in the Environment

- Can the agent driver query the environmnet 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.