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 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...

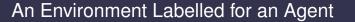
Motor Racing Simulation: The Scenario

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.



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 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 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.