ITCS 6150
Intelligent Systems

Lecture 2
Agents
What is an agent?

**Perception**

- Sensors receive input from environment
  - Sound/Voice data
  - Video/Image data
  - Signals registered within human brain (reading electrodes)

**Action**

- Impacts the environment
  - Move a robotic arm
  - Generates action shown on computer display
Evaluating agent programs

We agree on what an agent must do
Can we evaluate its quality?

Performance Metrics

• Very Important
• Frequently the hardest part of the research problem
• Design these to suit what you really want to happen
Rational Agent

For each percept sequence, a rational agent should select an action that maximizes its performance measure

Example: autonomous vacuum cleaner

• What is the performance measure?
  • Penalty for missing a spot?
  • Reward for speed?
  • Reward for conserving power?
Learning and Autonomy

**Learning**

- To update the agent function in light of observed performance of percept-sequence to action pairs
  - **Explore** new parts of state space
    - Learn from trial and error
  - Change classifiers that influence action selection
Adding intelligence to agent function

**At design time**
- Some agents are designed with clear procedure to improve performance over time. Really the engineer’s intelligence.
  - Camera-based user identification

**At run-time**
- Agent executes complicated computation to map input to output

**Between trials**
- With experience, agent changes its program
Qualities of a task environment

**Fully Observable**
- All aspects of state are available
  - Volume of observables may be overwhelming

**Partially Observable**
- Some data is unavailable
  - Maze & Noisy sensors
  - Instruments played in polyphonic music and Medical datasets
Qualities of a task environment

**Static**
- Environment doesn’t change over time
  - Crossword puzzle

**Dynamic**
- Environment changes over time
  - Driving a car

**Semi-dynamic**
- Environment is static, but performance metrics are dynamic
  - Drag racing
Qualities of a task environment

Towards a terse description of problem domains

- State space: features, dimensionality, degrees of freedom
- Observable?
- Predictable?
- Dynamic?
- Continuous?
- Performance metric
Simple Reflex Agents

Randomization

- The vacuum cleaner problem
Model-based Reflex Agents

So when you can’t see something, you model it!

• Create an internal variable to store your expectation of variables you can’t observe

• If I throw a ball to you and it falls short, do I know why?
  – Aerodynamics, mass, my energy levels…
  – I do have a model
    ▪ Ball falls short, throw harder
Admit it, you can’t see and understand everything

Models are very important!

• We all use models to get through our lives
  – Psychologists have many names for these context-sensitive models
• Agents need models too
Goal-based Agents

Lacking moment-to-moment performance measure

Overall goal is known

How to get from A to B?

- Current actions have future consequences
- **Search** and **Planning** are used to explore paths through state space from A to B
Learning Agents

**Learning Element**
- Making improvements

**Performance Element**
- Selecting actions

**Critic**
- Provides learning element with feedback about progress

**Problem Generator**
- Provides suggestions for new tasks to explore state space
A taxi driver

**Performance Element**
- Knowledge of how to drive in traffic

**Critic**
- Observes tips from customers and horn honking from other cars

**Learning Element**
- Relates low tips to actions that may be the cause

**Problem Generator**
- Proposes new routes to try and improved driving skills