A super fast introduction to autonomous agents

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Autonomous agents

- Agents: programs which
  - **sense** their environment
  - reason about their **goals**
  - **act** on the environment

Examples

- Not an agent: your word processor
- An agent: a thermostat, a computer virus, the antivirus program...

Secondary properties

- Mobility (in sense of mobile code)
- Inter-agent cooperation
- Internal representations (beliefs, desires)
- Planning

Inclusive definition

People used to get very hung up on the definitions. This time had passed. Everything which passes the sensing/goal/acting definition is an agent.

What does it buy me?

- It is a way of thinking about technological artifacts which can lead to new insights.
  - Better design, for instance.
  - Understand the interactions better.
  - Design such a way that the natural greed of components leads to a better societal results.
- Reuse of existing code
  - Agent frameworks, communication languages
  - Algorithms and analysis
  - Algorithmic code

Thinkin' agents

- the primary rule never forget greed
- agents are self interested (rational)
  - all the actions they take is to pursue their own goal
  - their social interactions are dictated by their rational pursuit of their goals
- an agent which does not pursue its goals is considered irrational

Simplest agent

- Define a utility function on the state of the environment $U(E)$
- Action $= argmax_A U(E + A)$

Limits to rationality

- There are several problems with the utility maximization example.
  - Probabilistic outcome over actions (ok, this is simple to solve, just take the expected utility)
  - Reasoning in time (environment changes while I keep thinking about the best action)
  - Cost of reasoning in terms of resources
- Humans do not do full rationality
  - Satisficing: Herbert Simon got the Economics Nobel for this
    - ★ Pick the first option which is good enough
  - Bounded rationality: limit the amount of time and resources spent on what we do.

Problems with rational agents

- Game theory deals with behavior of self-interested agents.
- The problem is that the emergent behavior is frequently societally undesirable.
  - Prisoner's dilemma / Tragedy of the commons
  - Game of chicken
- Nash equilibrium: (John Nash, of the Beautiful Mind fame, Economics Nobel)
  - There is a pair of behavior strategies which might not be optimal,
  - ...but there is no incentive for any individual player to deviate
- Pareto efficiency
  - There is no alternative deal which can make **all** players better of.
- Mechanism design.