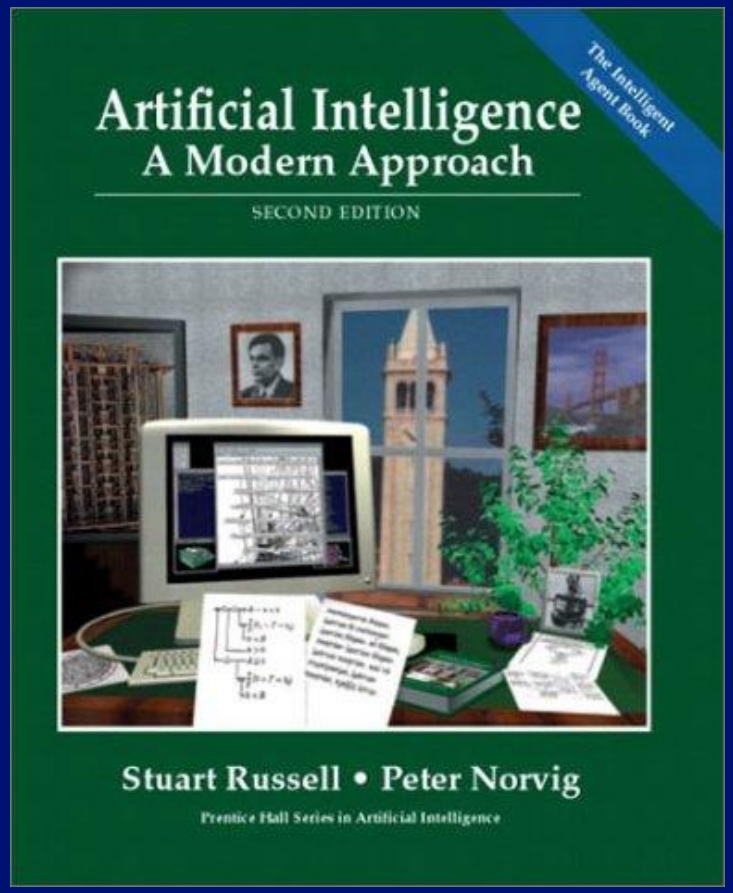
ITCS 6150
Intelligent Systems

Lecture 1

Introduction

Textbook

Most widely used in U.S. universities



Homework

- Read chapters 1 and 2

What is AI?

Discussion exercise for class

- Think of example AI systems (applications that are intelligent)
- Think of example AI Techniques

AI Systems

- Thermostat
- Tic-Tac-Toe
- Your car
- Chess
- Recommender Systems (collaborative filtering – based on similarity to other users; content-based filtering – based on similarity of items user liked in the past)
- Robots
- Washing Machine

AI Techniques

- Rule-based
- Logic, Modal Logic, Fuzzy Logic
- Granular Computing
- Machine Learning, Data Mining
- Evolutionary Algorithms (Genetic operators: crossover, mutation)

How to Categorize These Systems

Systems that think like humans

Systems that act like humans

Systems that think rationally

Systems that act rationally

Distinctions

How one thinks vs. How one acts

- How can I know how you think?
  - For the most part, you are a “black box”
  - Cognitive Science (study of human intelligence and behavior)
- How can I know how you act?
  - Observation
  - Turing Test

Rational vs. Human

Thinking/acting rationally vs.

Thinking/acting like a human

- Rely on logic rather than human to measure correctness
- Thinking rationally (logically)
  - Socrates is a human; All humans are mortal; Socrates is mortal
  - Logic formulas for synthesizing outcomes
- Acting rationally (logically)
  - Even if method is illogical, the observed behavior must be rational

What is AI?

The use of computers to solve problems that previously could only be solved by applying human intelligence…. thus something can fit this definition today, but, once we see how the program works and understand the problem, we will not think of it as AI anymore ***(David Parnas)***

Foundations - Mathematics

- More formal logical methods
  - Boolean logic (Boole, 1847)
- Analysis of limits to what can be computed
  - Intractability (1965) – time required to solve problem scales exponentially with the size of problem instance
  - NP-complete (1971) – Formal classification of problems as intractable
- Uncertainty (Cardano 1501)
  - The basis for most modern approaches to AI
  - Uncertainty can still be used in logical analyses

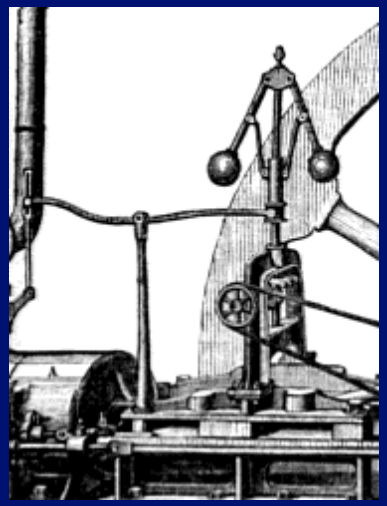
Foundations - Neuroscience

How do brains work?

- Early studies (1824) relied on injured and abnormal people to understand what parts of brain do
- More recent studies use accurate sensors to correlate brain activity to human thought
  - By monitoring individual neurons, monkeys can now control a computer mouse using thought alone
- Moore's law states computers will have as many gates as humans have neurons in 2020
- How close are we to having a mechanical brain?
  - Parallel computation, remapping, interconnections, binary vs. gradient…

Foundations – Control Theory

- Machines can modify their behavior in response to the environment (sense / action loop)
  - Water-flow regulator (250 B.C.E), steam engine governor, thermostat
- The theory of stable feedback systems (1894)
  - Build systems that transition from initial state to goal state with minimum energy
  - In 1950, control theory could only describe linear systems and AI largely rose as a response to this shortcoming



Foundations - Linguistics

Speech demonstrates so much of human intelligence

- Analysis of human language reveals thought taking place in ways not understood in other settings
  - Children can create sentences they have never heard before
  - Language and thought are believed to be tightly intertwined

Why is AI in Computer Science?

- Uses computer as a tool more than psychologists, mathematicians (operations research), or mechanical engineers (control theory)

AI History: 1969 - 1979

Knowledge-based Systems

- Previous systems knocked because general logical algorithms could not be applied to realistic problems
- Answer: accumulate specific logical algorithms
  - knowledge of scientists boiled down to cookbook logic
  - large number of special purpose rules worked well
- Researchers work on ways to accumulate and store facts for expert systems

AI History: 1980 - present

Let the good times roll

- The demonstrated success of AI invited investments
- from millions to billions of dollars
- extravagant AI promises again led to “AI Winter” when investments in technology dropped (1988)

Neural Networks come back from the dead (1986)