UNIVERSITY OF SAN FRANCISCO
CHANGE THE WORLD FROM HERE

Artificial Intelligence Programming – Computer Science 662

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TR, 9:55-11:40

Syllabus

- Canvas
- Office Hours
- Prerequisites: CS 245 or equivalent
  - You should be comfortable writing medium-sized programs
- Programming language & tools
  - Python
  - Will use some OTS tools
- Text book

Syllabus - II

- Test dates: check them now! Including final exam!
- Grading
  - Seven assignments, mostly programming but some problems – **65%**
  - Two midterms – **10% each**
  - Final exam – **15%**
- Collaboration

Topics

- Basic search
- Heuristic Search
- Adversarial search (games!)
- Logic and inference
- Knowledge representation
- Probabilistic reasoning
- Natural language processing
- Information retrieval
- Machine learning

Supporting Topics

- Python
- HTTP
- HTML, XML
- Misc!

Not covering

- Robotics
- Vision
- Signal processing

AI is a huge field!

We will just scratch the surface

Succeeding in AI

- Attend class, pay attention, and **ask questions**
  - There is no stupid question or imprecise question
  - If you are stumped, so are at least a few other people
- Talk to me in office hours – I'm on your side
- Manage your time, plan ahead
- Learn to break down assignments and take them a piece at a time – don't put off starting work on them
- Read the book, and **ask questions** about it

- You are the key to the success of the class!

What is Artificial Intelligence?

AI research

- In the broader world, people think AI is about the Terminator, Data, or other “human level” intelligence
- AI research is usually **much** narrower
  - Why?
- In some circles, AI is perceived as a failure
  - Depends on how you define it

- Let’s try…

Building Data

- Suppose we wanted to build Data
  - Or C3PO or any other AI
- What skills would it require?

Building Data

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  - Or C3PO or any other AI
- What skills would it require?
  - Language
  - Complex reasoning
  - Learning
  - Vision
  - Complex physical motion
  - Ability to act in noisy, complex environments
  - Integration of all of the above
- These are each huge research / development projects on their own!!

Some Definitions of AI

`concerned with intelligent behavior in artifacts' - Nilsson

`study of the design of intelligent agents' - Poole

`Creating machines that perform functions that require intelligence when performed by people.' - Kurzweil

`The automation of activities we associate with human thinking, such as decision-making, problem-solving, learning' - Bellman

`The study of the computations that make it possible to perceive, reason, and act' - Winston

So what's intelligence?

So what's intelligence?

There are many different types of intelligence

- Logical-mathematical intelligence
- Musical intelligence
- Spatial intelligence
- Verbal intelligence
- Kinesthetic intelligence
- Interpersonal intelligence
- and more ...

That didn’t help much…let’s change the question

Can machines think?

Can – is it possible to build a machine that thinks?

Searle: thought is a byproduct of human makeup - nothing less complex than a human can actually think.

- “Brains cause minds” - we are intelligent because we have evolved to function in a very complex, spatially rich world.
- Being completely embedded in the world is necessary for intelligence.

That didn't help much…let's change the question

Can machines think?

Newell and Simon: Physical Symbol System Hypothesis

A physical symbol system has the *necessary* and *sufficient* means for general intelligent action.

Symbols: letters, numbers, words, variables, etc.

A symbol system is a collection of symbols, plus the rules or means to combine them into new symbols.

- e.g. A CPU or a Turing machine

Symbols are used to construct a language or representation

Physical Symbol System Hypothesis

Necessary: symbol manipulation is required for intelligence.

- controversial; some feel that intelligence can be achieved purely through subsymbolic signal manipulation.
- For example, recognizing someone's face is not a symbolic task.

Sufficient - no other system or capability is required for intelligence if one has a PSS.

- Also controversial - some people argue that the agent must be grounded in a sufficiently rich world

Can Machines Think?

Can **machines** think?

We typically look at Turing-equivalent machines.

Perhaps other types of machines can be intelligent.

Cells can be programmed using DNA

We can argue that the human body is just a very complex machine.

We'll focus on standard stored-program computers in this class

Can Machines Think?

Can machines **think?**

- What does it mean for a machine (or a person) to think?
- How can we as scientists say that some external thing is thinking?
- How can we say that it is intelligent?
- How do I know that other humans are thinking?
- Maybe they’re just cleverly programmed automata?

Thinking, continued

"A system is intelligent if it *acts* like a human"

I assume people are intelligent because they act appropriately.

Can we apply this metric to a computer?

Thinking, continued

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Turing test

- Talk with a human and a computer about any topic over an IM-style interface.
- If a questioner cannot tell which is which, the computer must be intelligent.

Problems with the Turing test

Sufficient, but not necessary.

Only measures language and conversation.

- What about learning, problem solving, vision, etc ...

Test is subjective; depends on the questions asked.

Do we really want an intelligent machine to be indistinguishable from a human?

- Can’t do square roots, gets tired, can’t remember lists, etc.

What about complicated mimicry programs? Do they count?

Thinking, continued

"A system is intelligent if it *thinks* like a human"

If a system uses the same reasoning processes as a human, then it is intelligent.

How do humans think? ongoing research problem!

Researchers in cognitive science and psychology construct computational models of human problem solving.

Cognitive Modeling

Gives a way to “look inside” a model of the brain

Goal: better understand the human brain/mind.

Again, do we really want a machine to think “like a human”?

- Make logical errors
- Misestimate distances
- Bad at estimating probabilities
- Draw faulty conclusions
- …

Thinking, continued

"A system is intelligent if it thinks *rationally*"

Follow sound reasoning processes that always lead to correct outcomes.

Leads to the study of logic and formal reasoning

This used to be the dominant approach in AI.

However, logic has its problems

- Formalizing common-sense knowledge
- Dealing with uncertainty
- Computational issues

Thinking, continued

"A system is intelligent if it *acts* rationally"

Currently the most popular definition.

Sidesteps all the sticky questions.

A rational agent is one that acts so as to achieve the best possible (expected) outcome, given its knowledge and ability.

Not omnipotent or omniscient

Lets us work on smaller problems that require 'intelligence'

We can build agents that do certain tasks intelligently without having human-level intelligence

AI as an engineering problem

We'll focus on the engineering and design problems in AI. For example:

- How do we build a program that can learn to do a task?
- What sorts of knowledge is needed for a program to solve a word problem?

Less emphasis on cognitive and philosophical issues.

Past successes

Early AI researchers were overly optimistic.

- Solutions to simple problems didn't scale up.

"As soon as something works, it's no longer AI."

- Voice recognition
- Face recognition
- Optimal scheduling
- Automated translation
- Factory robots
- Object-oriented programming
- Expert systems

More recently…

Deep Blue, Chinook, TD-Gammon

Mars Rovers

DARPA Grand Challenge, Google self driving car

Soar

Logistics planning

IBM Watson

Siri

AI is everywhere

Information Processing

Expert Systems

Space exploration

Automated factories

Robotic search-and-rescue

Games and immersive environments

Electronic Commerce

Financial Management

Tutoring systems

…

Summary

Thinking humanly: cognitive modeling

Thinking rationally: pure logic

Acting humanly: Turing test

Acting rationally: rational “agents”

Summary and Preview

Philosophical questions are fun but not much help

We will concentrate on solving specific problems

Agent-based approach

- Unifies the disparate fields
- Will talk about it more in a week!

Other questions?