Let's Move on to the Second Part of Our Course

The first part of our course,
◦ Connecting the World,
◦ is done!
On Wednesday, we'll have our first exam.
Today, we start talking about Machine Intelligence.
(This material is not on the exam.)

Machine Intelligence: a Hot Topic for Business and Society

Today,
◦ bringing intelligence into machines
◦ is exciting the whole world.
Artificial intelligence (AI)
◦ is already used in many businesses
◦ as well as research, governments, and so on.
You’ll see more and more uses as the future unfolds.
AI has major implications for society.

Today: Discuss Meaning of Intelligence, Consider Search

Our plan for today:
1. Have a philosophical discussion
   ◦ (please participate!)
   ◦ about the meaning of “intelligence.”
2. Propose
   ◦ information search problems
   ◦ as a pathway to machine intelligence.
Next week, we’ll explore the most visible search service: web search.
Are Humans Uniquely Intelligent?

Among the many species on Earth, humans are known to be “intelligent.”

1. Do you believe that humans are intelligent?
2. Do you believe we’re the only species on Earth that is intelligent?
3. What makes humans intelligent?

Answers?
- use of language with syntax and grammar
- abstract pattern recognition in writing, numbers, and so forth
- create and utilize tools
- basing behavior on knowledge rather than instinct
- visualize concepts and objects that don’t necessarily exist (spatial reasoning)
- make fire

Answers from Previous Semesters

Some answers others have given:
- Humans can think and make complex decisions.
- Humans can make and use tools.
- Humans can use language with grammar and syntax.
- Humans can self-reflect, seeing themselves (somewhat) objectively / from the outside.
- Humans can reason abstractly. For example, “This sentence is a lie.”

Can Machines be Intelligent?

Can machines also be intelligent?

As intelligent as humans?

More intelligent than humans?

Why or why not?
Can Machines be Intelligent?

Last time, no one answered.
Let’s be specific with a range of examples…
- a calculator?
- a computer?
- a map service?
- Google web search?
- a Roomba robot?
- a rocket?
- a chess-playing computer?
- a self-driving car?

Examples of Machine Intelligence?

A calculator?
Pretty safe to say no.

Examples of Machine Intelligence?

A computer?
No?
Remember Church-Turing?

Many people would still say no:
- humans tell computers what to do.
- Can teach a dog to do any trick, but that doesn’t make the dog intelligent.
Examples of Machine Intelligence?

A map service?
No?
Actually,
* these use Breadth-First Search,
* which used to be
  * one of the primary examples
  * of “artificial intelligence!”
But most would probably agree today.

Google Web Search?
No?
Shreyas (first TA) said yes:
  * acts like a “friend,”
  * uses my preferences for reference.
A lot of people would probably agree.

Examples of Machine Intelligence?

A Roomba robot?
No?
Did you know that it
* moves around your house
* using active signal reflections
* to make a map?
You can ask it to see the map!

A rocket?
No?
So ... the rocket
  * launches
  * flies up to ISS, which is travelling at 4.76 miles per second,
  * matches speed to rendezvous, then
  * flies back down and lands itself standing upright.
And you say NO?
I'd probably agree.
But why are these things not intelligent?
Examples of Machine Intelligence?

The chess-playing computer that beat the human world champion?
Maybe you’ll say yes now?
Because it’s making decisions based on the other player’s game play?
(adapts to other people’s play)

How Do You Decide Your Answers?

Exercise was meant to help you think about what makes something intelligent.
• Chess player adapts, so most of us say yes.
• Self-driving car adapts to local traffic, accidents, pedestrians, bicyclists, and so forth.

What is the threshold / criterion for intelligence?

Examples of Machine Intelligence?

Self-driving car?

Machines Today Solve Problems that Humans Have Not

Today, machines can solve problems
• without humans teaching them explicitly
• how to solve the problems
For example, chess:
• which human could teach a computer
• to beat the world champion (of humans)?
Now becoming possible for machines
• to do things that even humans
• don’t know how to solve.
Success Metric: the Turing Test

Pat sits in a room with a computer.
Jan stands outside.
When someone asks a question,
  * Jan asks either the computer or Pat.
  * (50% to choose either, but always same.)
  * Then Jan comes out with the answer.

Can a human tell
  * whether Pat or the computer is answering
  * (with more than 50% success)?

ELIZA Passed the Turing Test

A program called ELIZA
  * by Joseph Weizenbaum in 1964-1966
  * simulated an empathetic psychologist
  * (the first “bot”).

Arguably, it beat the Turing test:
  * people refused to believe
  * it was a computer program
  * rather than a hidden human, and
  * people took their “conversations” with it seriously.

The DOS version from 1988, which isn’t as good:
https://www.dosgames.com/game/eliza

Until Recently, Computers Could Not Perform Recognition

What question would you ask?

Maybe: How many humans are in the picture?

A decade ago, a computer would not be able to answer.

Neither Could Computers Read Oddly Written Text

How about a captcha?

Again, computers could not identify the characters.

That’s why captchas were useful in preventing bots from creating accounts and doing other things.
Can You Come Up with a Question for the Turing Test?

What about these questions today?
   Capitol of Nebraska?
   Recognize a song?
   Chess move for checkmate?
   Drive a car in a game?
   Maybe the computer will have to lie?
Not easy to come up with a good question.

Intelligence: Just what is It, Anyway?

The notion of intelligence is a subject of much investigation.

Think about it, and
   • view this part of course through this lens:
   • What does it take to make machines “intelligent?”

Claim: Search is Fundamental to Intelligence

Claim: search is fundamental to intelligence

Examples
1. best tic-tac-toe move
2. finding musical phrases
3. Is that a dog, or a cat?
Let’s look at each in more detail.

Searching for a Move in Tic-Tac-Toe

What is the next best move for X?
Searching for a Musical Phrase

Now where have we heard that phrase?

Search a database of songs for matches!

But did you want the original
- or a modern piece
- in which the composer
- made use of a familiar phrase?

Object Recognition an Important Part of Computer Vision

What do you see in the picture?
Identifying animals,
- even if it's just a dog or a cat,
- seems like an “intelligent” action.

In fact,
- object recognition has been
- an important part of computer vision
- for decades.

Best Recognizers Now Use Search, Appear Intelligent

Recently, though,
- the approach taken by the best systems
- has been more like a search problem.
And computers are good at those.

If machines
- can solve search problems quickly,
- they can appear intelligent.

A Challenge for You

Can you come up with a problem that can't be solved by search?
Another Example: Web Search

Here’s another example:
There’s so much content scattered over the edge of the Internet.
Given a topic,
◦ how can I find
◦ the most relevant and interesting pages?

Web Search an Important Problem

What if you don’t know they exist?
Search for them! Look everywhere!
Web search
◦ was the “killer app” for networks of workstations,
◦ a predecessor of the modern datacenter.
A company named Inktomi had the best technology (and most of the market),
But Google bought the company that invented the idea of selling ads for search responses.

How Does Web Search Operate?

Steps in an Internet search service:

1. Alice searches with phrase P
2. Search engine finds
   ◦ a large set of scattered documents D
   ◦ that contain P or are relevant to P:
   ◦ D = {d1, d2, ..., d203}

3. search engine rank orders D by “relevance”:
   ◦ D = [d17, d105, d23, d39, ..., d12]
   ◦ "relevance" could depend on the searcher
      ◦ History of Nike (history professor) -> Greek goddess
      ◦ History of Nike (political scientist) -> Nike missile
      ◦ History of Nike (CEO of company) -> Nike shoes
      ◦ History of Nike (comparative literature expert) -> Borges*
   ◦ Or on who pays the search engine company!
4. show results of search quickly
Next Monday: anatomy of a search engine
   "Pierre Menard, autor del Quijote," 1939.
Comments on Our First Exam

- **in-person in this room**, 11:00-12:00
- content
  - similar to exercises, study guide
  - but much shorter (1 hour long)
- **no books/slides/Internet, no calculator**
- **1 page (8.5×11”) cheat sheet** allowed (both sides)
  - make notes about methods, terminology
  - put your name on it and turn it in with exam
  - (make a copy beforehand if you want to keep)