University of Illinois at Urbana-Champaign
Dept. of Electrical and Computer Engineering

ECE 101: Exploring Digital Information Technologies for Non-Engineers
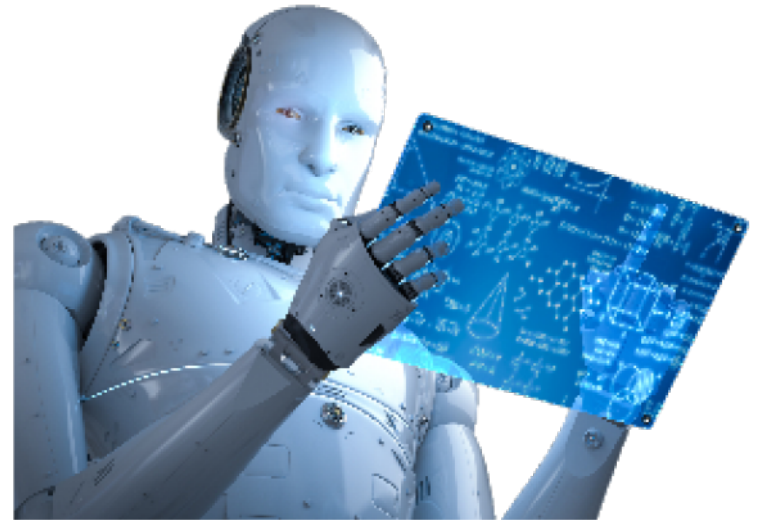

Introduction to Machine Intelligence

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

The first part of our course,
- Connecting the World,
- is done!

Today, we start talking
about Machine Intelligence.

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 class, 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?**
   (Answer on next slide)

What makes Humans Intelligent

Answers suggested by the class:

- Problem solving skills

- Complex emotions

- Ability to learn from past experiences

- Communicate effectively; Language

- Self-awareness

- Adapting to surroundings; Manipulate the environment

- 5 senses

- Moral compass; Conscience

- Consider consequences of actions; Foresight

- Creativity; Symbolic thinking—Rituals

- Record and pass on wisdom through generations

Answers from Previous Semesters

- Instant adaptability
- Use complex language to communicate
- Take in information and synthesize answers; draw conclusions
- Ability to think; make decisions
- Instantly recall past knowledge
- Know how to learn from mistakes
- Creativity and creative expression across mediums
- Empathy - understand others
- Morality (*principles concerning the distinction between right and wrong or good and bad behavior - Oxford Languages powered Google dictionary*)

Answers from Beyond ECE101

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."

Let's Poll

Can machines also be intelligent?

As intelligent as humans?

More intelligent than humans?

Why or why not?

YES

- machines are more logical; faster at working through logical implications and considering many cases

- humans make mistakes; machines do not

- machines can't adapt their axioms, but humans can

NO

- machines don't have to worry about instinct, ethical, cultural considerations

Let's look at a few specific machines

- 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 Hypothesis?
"Computers and humans can compute the same things"

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.
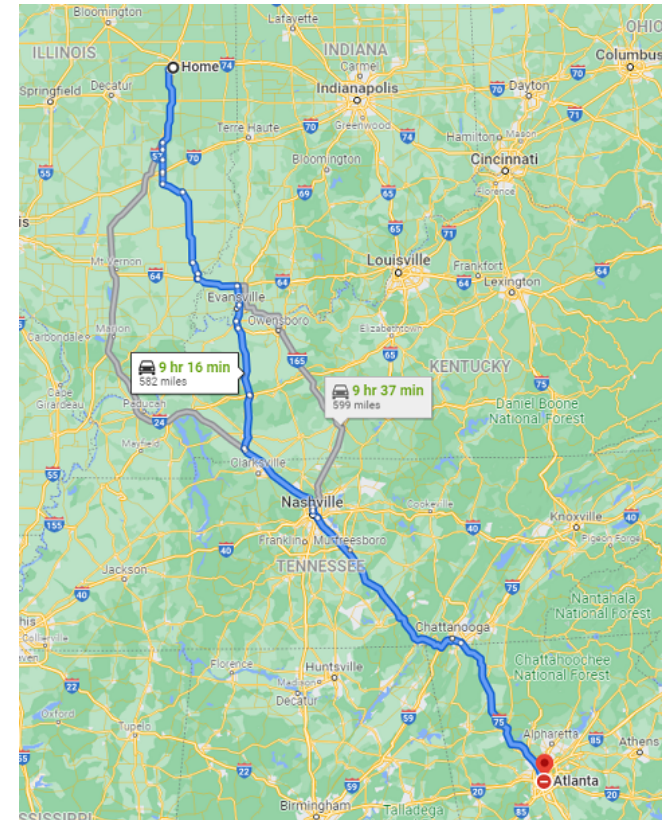
Examples of Machine Intelligence?
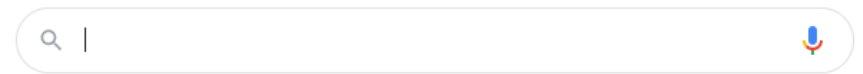
Google Web Search?

No?

Comments from earlier students:
- 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!

Examples of Machine Intelligence?

A rocket?

No?

So … the rocket
- launches
- flies up to ISS, which is traveling 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)

Examples of Machine Intelligence?
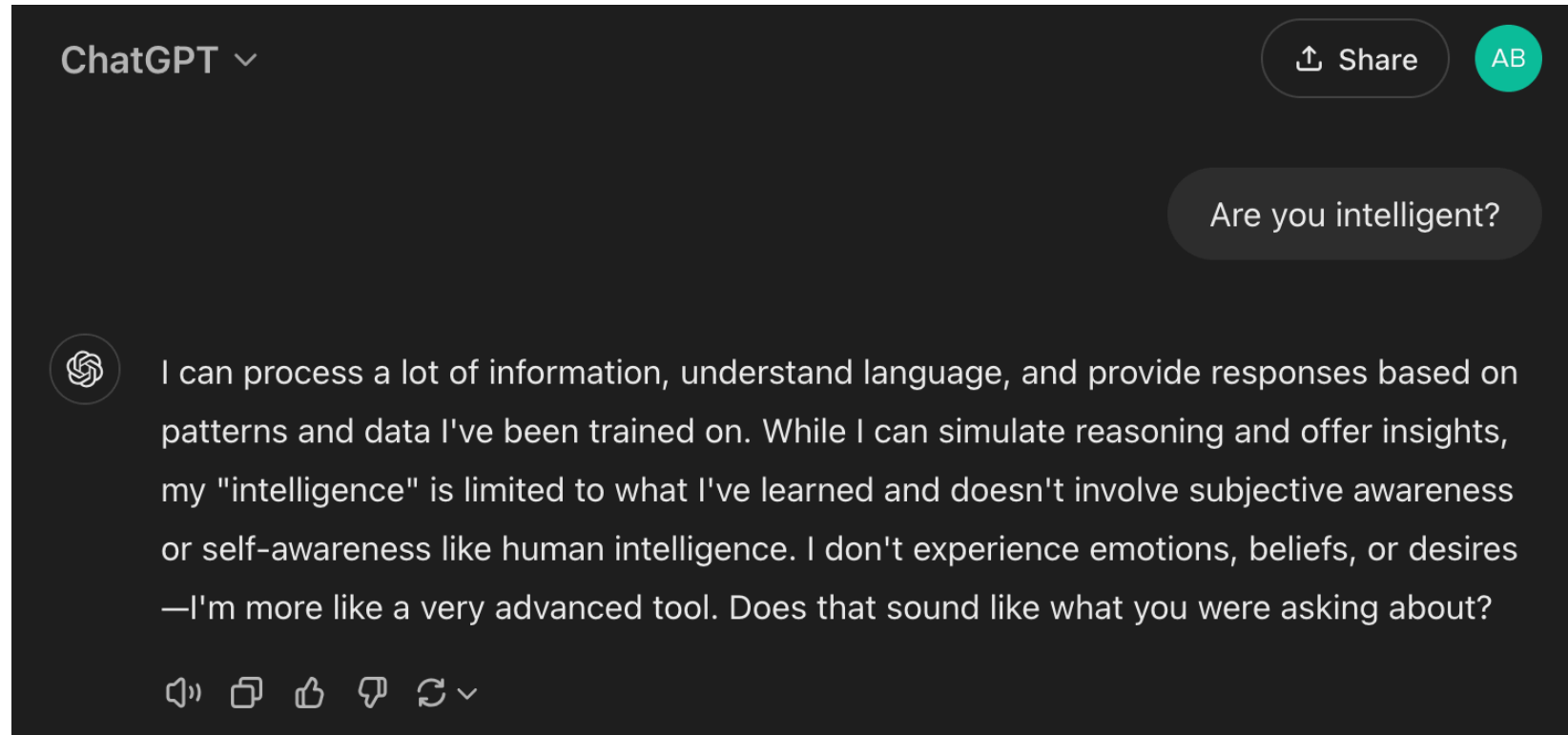
Self-driving car?

ChatBot

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?**

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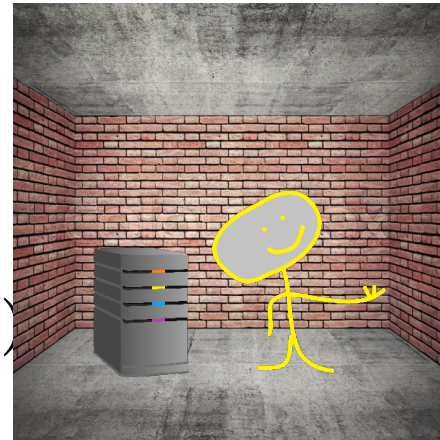
Can a human tell
- **whether Pat or the computer is answering**
- **(with more than 50% success)?**

The Turing Test: Created by Alan Turing; The Imitation Game: A computer can be said to possess artificial intelligence if it can mimic human responses under specific conditions.

Human or Computer?

What would you ask to test whether a human or a computer is answering? (Answer on Canvas)

- What is the capital of Nebraska?

- How many humans in this picture?

- What is this word?

- Drive a car in this video game without crashing?

ELIZA Passed the Turing Test

A program called ELIZA
- by Joseph Weizenbaum in 1964-1966
- simulated an emphathetic psychologist
- (the first "bot").

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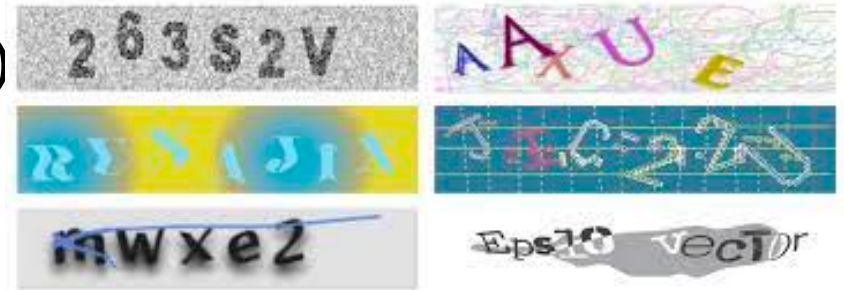 - rather than a hidden human, and
- people took their "conversations" with it seriously.

The DOS version from 1988, which isn't as good:

https://www.dosgames.com/game/eliza

```
Welcome to
              EEEEEE  LL     IIII  ZZZZZZ   AAAAA
              EE      LL      II       ZZ  AA  AA
              EEEEE   LL      II      ZZZ  AAAAAAA
              EE      LL      II     ZZ    AA  AA
              EEEEEE  LLLLLL IIII ZZZZZZ   AA  AA

 Eliza is a mock Rogerian psychotherapist.
 The original program was described by Joseph Weizenbaum in 1966.
 This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```

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.

Type the characters above:

Go

okta

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

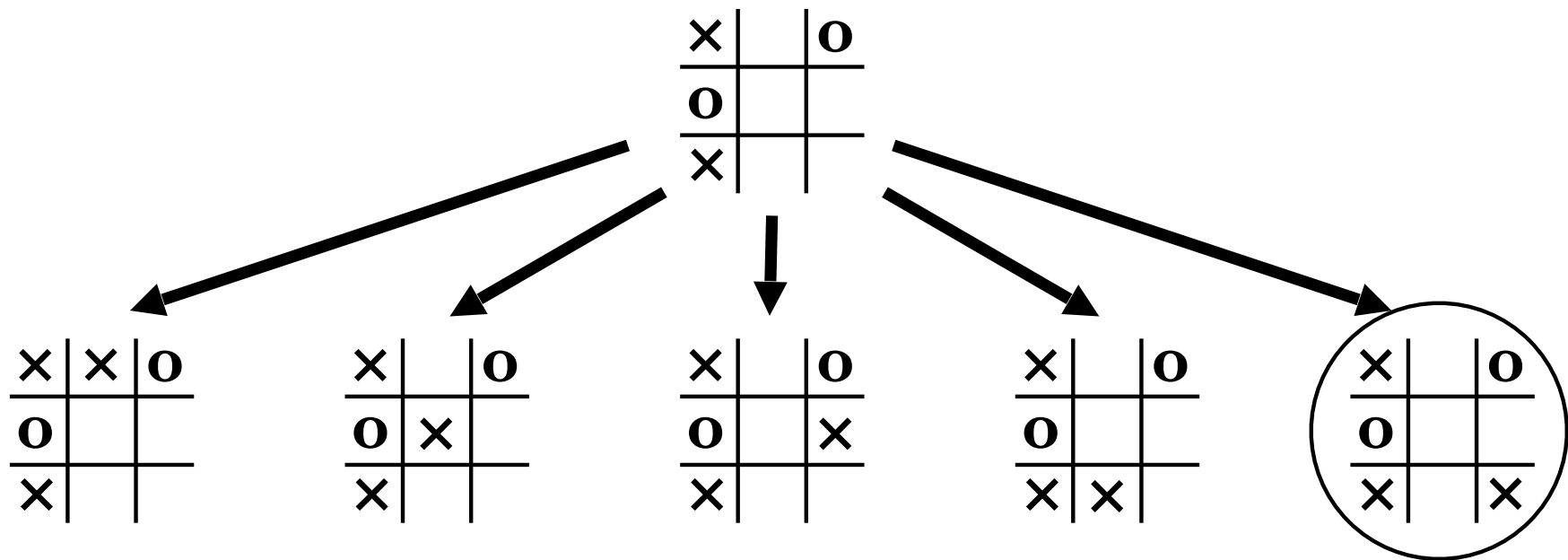Claim: **search is fundamental to intelligence**

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 ✕ ?

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.

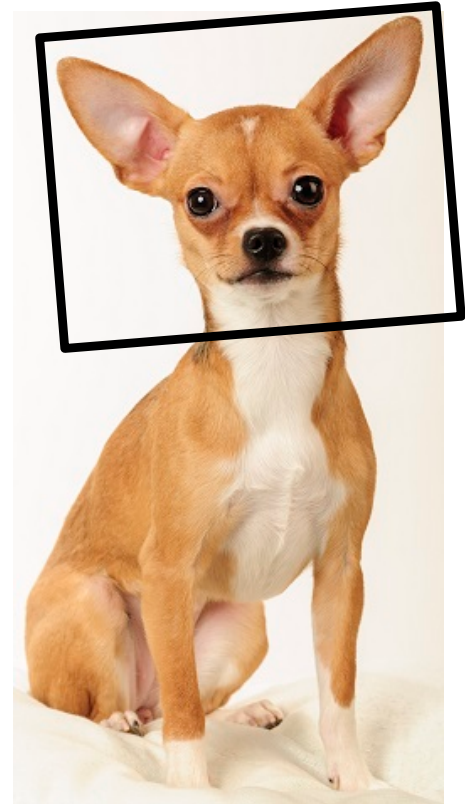# Best Recognizers Now Use Search, Appear Intelligent

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:
   - $D = \{d_1, d_2, \ldots, d_{203}\}$

How Does Web Search Operate?

3. search engine rank orders D by "relevance":
- D = $\{d_{17}, d_{185}, d_{23}, d_{29}, ..., d_{12}\}$
- "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.