**CS 112  Introduction to Programming**  
(Spring 2012)  
**Lecture #37: AI and Future of CS**  
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**Artificial Intelligence**

**Fundamental questions.**
- Is real life described by discrete rules, or not?
- Can we build an intelligent computer from living components?
- Can a machine do anything a human can do?
- Can human intelligence be simulated by a machine?

**Artificial Intelligence (AI).** The science and engineering of making intelligent machines.

![Human Brain and Intel Core i7 Microprocessor](image)

**Weak AI**

*Can a machine appear intelligent?*

**Goal.** [Turing 1950] Program computer to exhibit intelligent behavior.

"Every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it." — J. McCarthy *51*

1960s. Very optimistic predictions.

Reality. Slow progress (with some striking successes).
The Chess-Playing Turk

Tic-Tac-Toe

Tic tac toe. Two person game of skill.

Number of possible games. 255,168.

Minimax algorithm.
- If game over, return winner.
- If X's turn, return max score of children.
- If Y's turn, return min score of children.

Tic-tac-toe is solved. X will never lose; O will never lose.
assuming optimal play by X

Chess

Challenge. [Claude Shannon] Develop a computer program to play chess.

Number of possible games. \( \approx 10^{23} \).
N-by-N version. EXPTIME-complete.
Kasparov vs. Deep Blue

Deep Blue. [IBM]
- Supercomputer, augmented by VLSI chess chips.
- 200 million board positions per second.


Q. Does Deep Blue appear intelligent?

Turing Test

Can a machine appear intelligent? If so, how could we tell?

Turing Test

Judge types questions to both.
- Computer claims to be human.
- So does human.

Pass. If judge cannot tell which entity is human, we say computer has passed the test and is "intelligent."


Poker

Poker. Multi-player game of skill and luck.

Texas hold 'em poker bots. Not currently competitive with pros.
Eliza

Eliza. [Weizenbaum 1966]
- Program imitates Rogerian psychiatrist.
- Works by generating scripted responses to keywords.
- Just 200 lines of code!

Q. Does Eliza appear intelligent?
A. You be the judge: http://chayden.net/eliza/Eliza.html

Eliza Pattern Matching Rules

Parry

Parry. [Colby 1972] Program imitates a paranoid schizophrenic.

Q. What happens when Parry “meets” Eliza?

Turing Test

Loebner Prize
- $100,000 to first program to pass restricted Turing Test.
- Annual competition held since 1995.
- Small awards given to best programs.
"Hello, Judge. My name is Ella. Please tell me your first name, or whatever I should call you."

"Call me Lisa. Am I male or female?"

"Okay, I will call you 'Lisa. Am I Male Or Female?' I am here recently from Tainjin, China, so please be patient with me."

"I'm not a patient because I am not ill. Are you feeling well today?"

"What do you think it means that you are not ill?"

"Have you ever been ill?"

"Have you ever been ill?" you say? That's it, Lisa Am I Male Or Female? I will schedule a whipping for you."

"What do you think of Reading?"

"I'm somewhat crazy about reading. I like to read mystery novels."

"I meant the town."

"Jones lives in the city and is a writer of children's books."

"Does Jones live in Reading, then?"

"Tomorrow is another day. We can only live today well."

"Do you live, then?"

"I live then a lot. Someday we will live on another planet."

"I think you are already there."

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### Digression: "Reverse" Turing Test

**Standard Turing test.** Judge is human.

**Reverse Turing test.** Judge is computer!

**Why?**

- Google allows each user 7GB storage.
- PayPal once offered $5 for each user who opens a new account.
- Both need to distinguish real humans from bots.
Exploiting Intractability: Captcha’s

OCR. Given degraded text, find original text.

CAPTCHA. [completely automated public Turing test to tell computers and humans apart]

http://online.wsj.com/public/resources/images/OB-AB313_captcha_20060524170113.gif

Knowledge Databases

Twenty questions. http://www.20q.net

Question answering system. http://start.csail.mit.edu

Q. Does a computer that can answer questions appear intelligent?

IBM Watson

IBM Watson. Capable of answering questions posed in natural language.

- Combination of natural language processing, information retrieval, machine learning, and massively parallel computing.
- Massively parallel computer.
- Written in Java and C++.

Challenge. Play Jeopardy competitively against best human players.

Watson vs. Brad Rudder vs. Ken Jennings
Will Watson Put Your Job in Jeopardy?

Q. What to do with Watson now?
A. Many commercial applications in the works.
- Business logic.
- Medical diagnoses.
- Legal research.
- ...

“The goal is to have computers start to interact in natural human terms across a range of applications and processes, understanding the questions that humans ask and providing answers that humans can understand and justify.” – The DeepQA Project

Strong AI

Can a machine be intelligent?

Chinese Room Experiment (Searle 1980)

Imagine that:
- You don’t understand Chinese.
- You’re alone in a room that has paper slots labeled “input” and “output.”
- You have a big book of Chinese writing.
- You have English instructions (but no translations) that tell you what to write on your output paper in response to various inputs.
Chinese Room Experiment (Searle 1980)

And then:
- Chinese speakers outside the room pass in pieces of paper with Chinese writing. They know these are questions (but you don’t).
- You consult your manual of instructions, figure out the proper Chinese response, copy it down, and pass it out.

Q. The folks outside think you understand Chinese. Do you?
Q. If a computer did the same, would it understand Chinese?

Strong AI. Can machines be programmed to possess intelligence?
Searle. Chinese Room is absolute refutation of strong AI.
But... many disagree!

“ The question of whether a computer can think is no more interesting than the question of whether a submarine can swim.” – Edsger Dijkstra

An interesting question, but... either way, limitless possibilities remain for applications of computer science.
2004 Grand Challenge. Navigate an autonomous vehicle through 142 mile course in Mohave Desert at military speed.

**Results.** [failure]
- Sandstorm (CMU). Reached mile 7.4. Vehicle went off course, got caught on an obstacle and rubber on the front wheels caught fire.

2004 Grand Challenge. Navigate an autonomous vehicle through 142 mile course in Mohave Desert at military speed.

**Results.** [failure]
- Alice (Caltech). Reached mile 1.3. Vehicle went through a fence, and couldn’t come back through.
DARPA Grand Challenge

**2004 Grand Challenge.** Navigate an autonomous vehicle through 142 mile course in Mohave Desert at military speed.

**Results.** [failure]
- Rocky (Virginia Tech). Vehicle brakes locked up in the start area.

DARPA Grand Challenge

**2004 Grand Challenge.** Navigate an autonomous vehicle through 142 mile course in Mohave Desert at military speed.

**Results.** [failure]
- David (ENSCO). Vehicle flipped in the start area, experienced a fuel leak, and the team needed to shut off the fuel.

DARPA Grand Challenge

**2005 Grand Challenge.** Navigate an autonomous vehicle through 132 mile course in Mohave Desert at military speed.

**Results.** [success] Stanford team won in under 7 hours; $2 million prize.

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DARPA Grand Challenge

**2007 Urban Challenge.** Navigate an autonomous vehicle through 60 mile course in mock urban environment, while obeying traffic laws and avoiding other vehicles.

Stanley (Stanford Racing Team) failed because of a performance bug, which starved code to control steering.
DARPA Grand Challenge

**2007 Urban Challenge.** Navigate an autonomous vehicle through 60 mile course in mock urban environment, while obeying traffic laws and avoiding other vehicles.

The six finishers of 2007 Urban Challenge