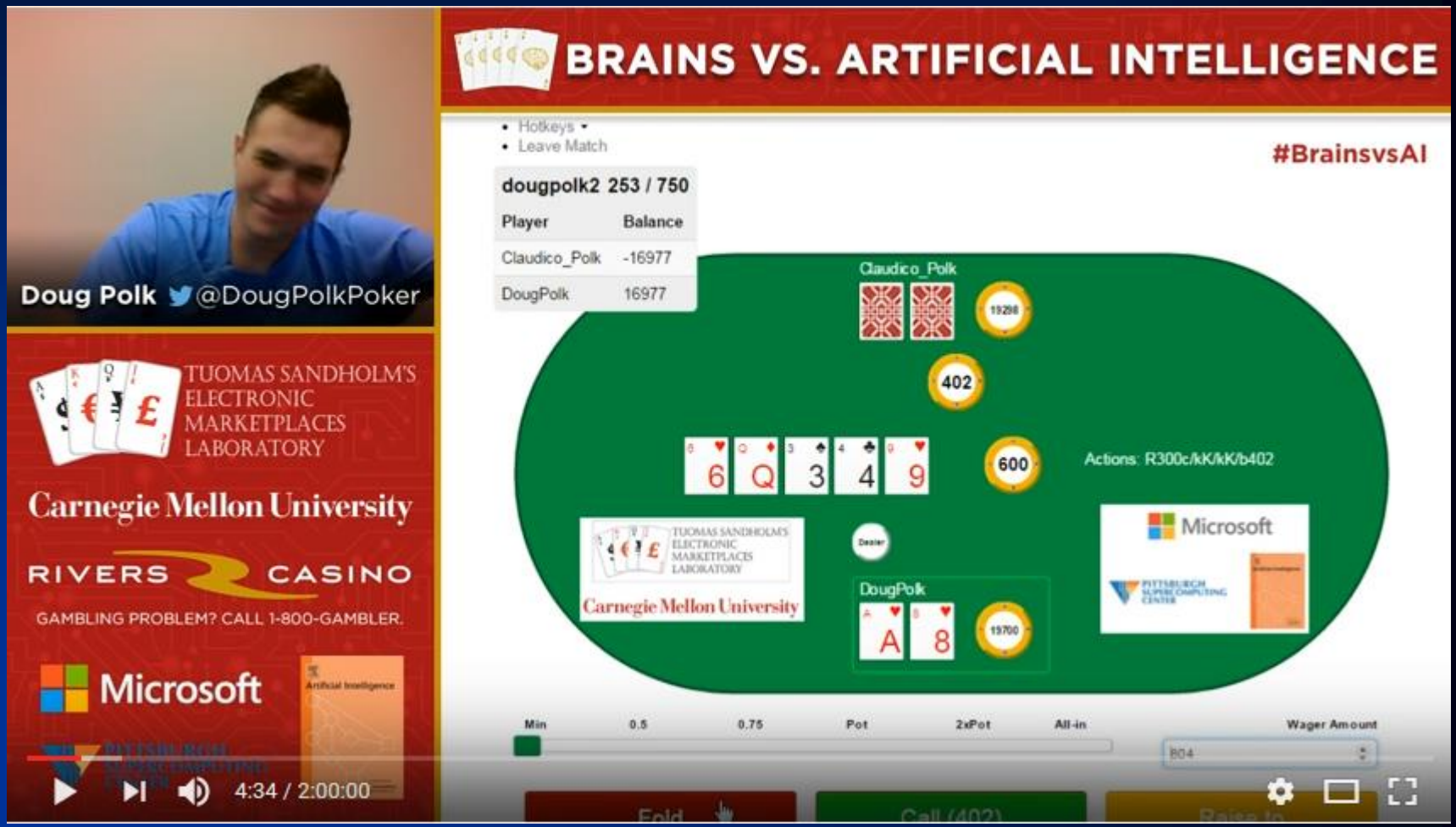
CAP 4630
Artificial Intelligence

Instructor: Sam Ganzfried

sganzfri@cis.fiu.edu

Brains vs. AI Competition

- https://www.youtube.com/watch?v=phRAyF1rq0I



What is AI?

Thinking Humanly	Thinking Rationally
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

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Acting humanly

- Turing test: https://www.youtube.com/watch?v=sXx-PpEBR7k
- Russian “chatterbot” Eugene Goostman passes it in 2014
  https://www.youtube.com/watch?v=OcY8xlPffcA
  https://www.youtube.com/watch?v=KNxALt_7F2k

- Eugene Goostman is portrayed as being a 13-year-old boy from Odessa, Ukraine, who has a pet guinea pig and a father who is a gynaecologist. Veselov stated that Goostman was designed to be a "character with a believable personality". The choice of age was intentional, as, in Veselov's opinion, a thirteen-year-old is "not too old to know everything and not too young to know nothing". Goostman's young age also induces people who "converse" with him to forgive minor grammatical errors in his responses.

Acting humanly

- **Natural language processing** to communicate effectively in English
- **Knowledge representation** to store what it knows or hears
- **Automated reasoning** to use the stored information to answer questions and to draw new conclusions
- **Machine learning** to adapt to new circumstances and to detect and extrapolate patterns.

Acting humanly

- **Total Turing Test** includes video signal so the interrogator can test the subject's perceptual abilities, as well as the opportunity for the interrogator to pass physical objects "through the hatch." To pass the Total Turing Test, the computer will need:

- **Computer vision** to perceive objects
- **Robotics** to manipulate objects and move about

Thinking humanly

- If we are going to say that a given program thinks like a human, we must have some way of determining how humans think. We need to get *inside* the actual workings of human minds. There are 3 ways to do this:
  - Through introspection: trying to catch our own thoughts as they go by
  - Through psychological experiments: observing a person in action
  - Through brain imaging: observing the brain in action
- The interdisciplinary field of **cognitive science** brings together computer models from AI and experimental techniques from psychology to construct precise and testable theories of the human mind

Thinking rationally

- Aristotle's **syllogisms**:
  - "Socrates is a man; all men are mortal; therefore, Socrates is mortal."
- Field of **logic**.
- Two obstacles:
  - It is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain.
  - There is a big difference between solving a problem "in principle" and solving it in practice. Even problems with just a few hundred facts can exhaust the computational resources of any computer unless it has some guidance as to which reasoning steps to try first.

Acting rationally

- A **rational agent** is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.
- Two advantages over other approaches:
  - More general than "thinking rationally" approach because correct inference is just one of several possible mechanisms for achieving rationality.
  - More amenable to scientific development than are approaches based on human behavior or human thought. The standard of rationality is mathematically well defined and completely general.

Relation to other fields

- Theoretical computer science:
  - Emphasis on proving theorems
- Computer science systems and programming languages
  - Emphasis on engineering systems
- Operations research/optimization
- Probability and statistics
- Machine learning and “data science”
- Philosophy
- Mathematics
- Economics
- Neuroscience
- Psychology, computer engineering, control theory and cybernetics, linguistics, …

Wikipedia and my definitions of AI

- In computer science, the field of AI research defines itself as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of success at some goal.
- AI is about creating real agents for solving interesting/important (large-scale) problems.
  - Pragmatic programming and implementation issues are very important in building real agents.
  - However, ideally the agents are not just based on "hacks" or random engineering heuristics, and there is also some deeper fundamental theory that justifies their performance. But producing strong "theory" is not the end goal.

Class summary

- Introduction to all major topics in artificial intelligence including search, logic, optimization, constraint satisfaction, planning, multiagent systems, machine learning. The class prepares students for advanced study and research in each of the individual topics and provides students with tools to apply the approaches to numerous industrial applications. The assignments involve a mix of theoretical and implementation exercises.

Topics

- Search
  - uninformed search, informed search, local search, adversarial search, constraint satisfaction
- Logic
  - propositional logic, first-order logic, logical inference
- Optimization
  - integer optimization, linear optimization, nonlinear optimization
- Planning
  - classical planning, spatial planning
- Probability
  - Bayesian networks, hidden Markov models
- Decision making
  - Markov decision processes, multiagent systems, reinforcement learning
- Machine learning
  - classification, regression, clustering, deep learning

Background

- Students should be familiar with all the material in this document on mathematical proofs and with at least one standard programming language (e.g., Python, C, Java).

- “The class prepares students for advanced study and research in each of the individual topics”
  - Machine learning/data science
  - Robotics/planning/vision/NLP
  - Game theory/multiagent systems
  - Optimization/operations research

- “and provides students with tools to apply the approaches to numerous industrial applications”
  - Finance
  - Biology
  - Robotics/navigation (e.g., Uber)
  - Social media
  - Other industries and careers?

- Class website: http://www.ultimateaiclass.com/
- Lecture videos: https://lecturecapture.fiu.edu/Mediasite/Catalog/catalogs/cap-4630-fall-2017
- https://moodle.cis.fiu.edu/ for announcements

Evaluation

- Homeworks (every 1.5-2 weeks, 4-5 in total), midterm exam, final exam, class project, each worth 25% of the final grade.
- Homeworks due at start of class at 2pm, otherwise late.
- Four total “late days” for homeworks at no penalty. Then 50% off, then 0% credit after 5^{th} late day.
- There will be a curve to determine final letter grades.

Project

- For the class project students will implement an agent for 3-player Kuhn poker. This is a simple, yet interesting and nontrivial, variant of poker that has appeared in the AAAI Annual Computer Poker Competition. The grade will be partially based on performance against the other agents in a class-wide competition, as well as final reports and presentations describing the approaches used. Students can work alone or in groups of 2.

Textbooks

- Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig (required)
- Operations Research Models and Methods by Paul Jensen and Jonathan Bard (optional)
- Learn Python the Hard Way by Zed Shaw (optional)

“Stuart Russell and I have started on a revision of our AI text. There is quite a lot of new work to cover, obviously in machine learning, and also the progress in poker has been impressive. Do you have advice on what we should put in the book, on poker in particular, and in general on adversarial search in partially observable domains?”

Thanks,

-Peter Norvig

- University drop date: 10/30
- Attendance is encouraged but not mandatory. Lectures slides will be posted on the class website after class. Lectures may also be recorded.
- Students can use laptops during class provided it is not disruptive to others.

Homework for next class

- Handout Introduction to mathematical arguments
- https://learnpythonthehardway.org/
- Python tutorial during part of next lecture