COMP 424 - Artificial Intelligence
Lecture 1: Introduction to AI

Instructor: Jackie CK Cheung (jcheung@cs.mcgill.ca)

Class website:

http://cs.mcgill.ca/~jcheung/teaching/winter-2017/comp424/index.html

Based on slides by Joelle Pineau

Outline for Today

- Recap of course basics
- Overview of AI history
- Approach to teaching AI
- Examples of AI applications

About Me

Education:

- BSc in Computer Science (UBC) 2004-2008
- MSc / PhD in Computer Science (Toronto) 2008-2014
- Prof at McGill 2015-

What kind of AI research do I do?

- Natural language processing and computational linguistics
- Artificial intelligence (as it relates to natural language)

Several Current Projects

- Common-sense reasoning

  The city councilmen refused the demonstrators a permit because they [feared/advocated] violence.

- Stylistic transfer in text

  e.g., news article –> informal tweet

- Sentence fusion and rewriting

  1. *He missed the 2009 season because of citizenship issues*
  2. *He returned to the international scene in early 2010.*

  ↓

  After having missed the 2009 season because of citizenship issues, he returned to the international scene in early 2010.

Student collaborators: Victor Chenal, Ali Emami, Jad Kabbara

About You

201 registered, from a variety of departments / faculties

- Computer Science
- Software / Electrical / Mechanical / Chemical Engineering
- Mathematics / Statistics / Physics
- Biology / Biochemistry
- Neuroscience / Cognitive science / Psychology
- Linguistics / Philosophy
- Economics / Accounting
- Music
- Exchange

Teaching Team

TAs:

Ali Emami

Christopher Glasz

Michael Noseworthy

Harsh Satija

Matthew Smith

- TA office hours to be posted

Best way to contact us: e-mail (see course syllabus for addresses)

- Target response time: 24 hours (but no guarantees)
- Plan ahead for questions related to assignments and exams

Artificial Intelligence

Course Topics

- Search
- Game playing
- Logical reasoning
- Classical planning
- Probabilistic reasoning
- Learning probabilistic models

- Reasoning with utilities
- Sequential reasoning and decision-making.
- Learning complex sequential decisions.
- Applications

Basic tools

Logical representations

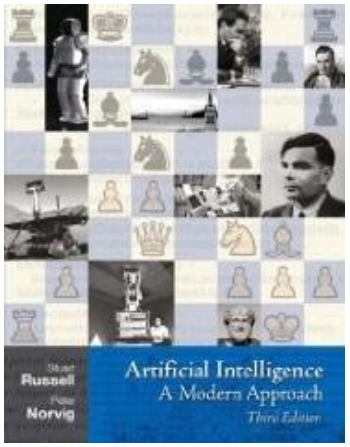
Probabilistic representations

Utility theory

About the Course

Textbook **(Required)**:

Russell & Norvig. "Artificial Intelligence: A Modern Approach", 3rd ed.



Evaluation:

1. Four individual assignments (20%)
2. Project: Implementation and written report (20%)
3. Midterm (20%)
4. Final exam (40%)

- Lecture notes (slides), assignments, solutions, project information, all available on *myCourses*.
- Lectures will be recorded and available on *myCourses*.

Course Project

- Design and implement a **game playing program**.
- Use ideas from the course to design your algorithm.
- Basic code (for a random player) will be provided in Java.
- You can use any programming language.
- Enter your program in a tournament against programs from other students.
- Evaluation: 50% code and competition results, 50% written report.
  - Written report must be clear, complete, including appropriate references.
  - Code must compile and run.

Coursework Policy

- **Format of coursework**: Some programming, some theory, some problem-solving, some application.
- **Assignments are individual**, submitted through *myCourses* by 11:59pm on the due date.
- **Project** should be submitted also on *myCourses*. **Late submissions are subject to 20% penalty up to 5 days**; after this will not be accepted.
- Late assignments will NOT be accepted.
- No make-up midterm will be offered.
- Accommodation for missing work with valid excuse: weight shifted to the final exam

Expectations

- **You must have taken the pre-reqs to register.**
- Come to class prepared, do the readings, follow the lectures.
- Ask questions, be engaged in your learning, be willing to work hard.
- Keep up with the assigned coursework.
- Respect the coursework policy.
- Use technology (email, discussion boards) appropriately.

Read This Carefully

- **Some of the course work will be individual, other components can be completed in groups.** It is the responsibility of each student to understand the policy for each work, and ask questions of the instructor if this is not clear.

- It is the responsibility of each student to **carefully acknowledge all sources** (papers, code, books, websites, individual communications) using appropriate referencing style when submitting work.

Automated Plagiarism Detection

- **We will use automated systems to detect possible cases of text or software plagiarism.** Cases that warrant further investigation will be referred to the university disciplinary officers. Students who have concerns about how to properly use and acknowledge third-party software should consult the course instructor or TAs.

This Neat Trick Will Raise Your Mark!

- Don't use your laptop or mobile device in class!

  News article: http://www.cbc.ca/news/technology/laptop-use-lowers-student-grades-experiment-shows-1.1401860

- Also distracting to your peers behind you, if you are not using it for course purposes

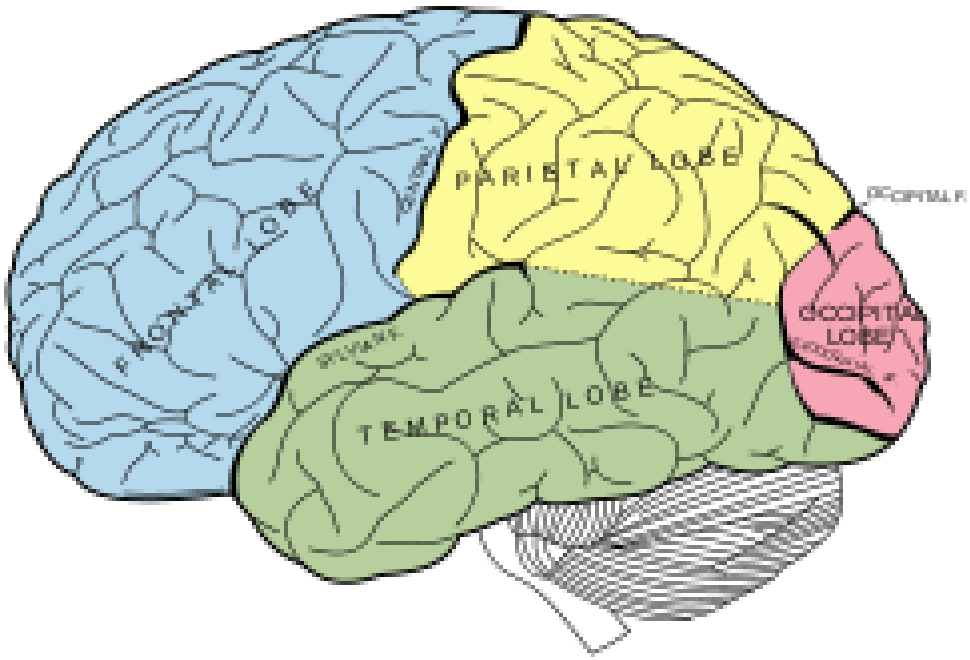
Laptop-free zone:

- Laptops are forbidden in the first three rows

Questions?

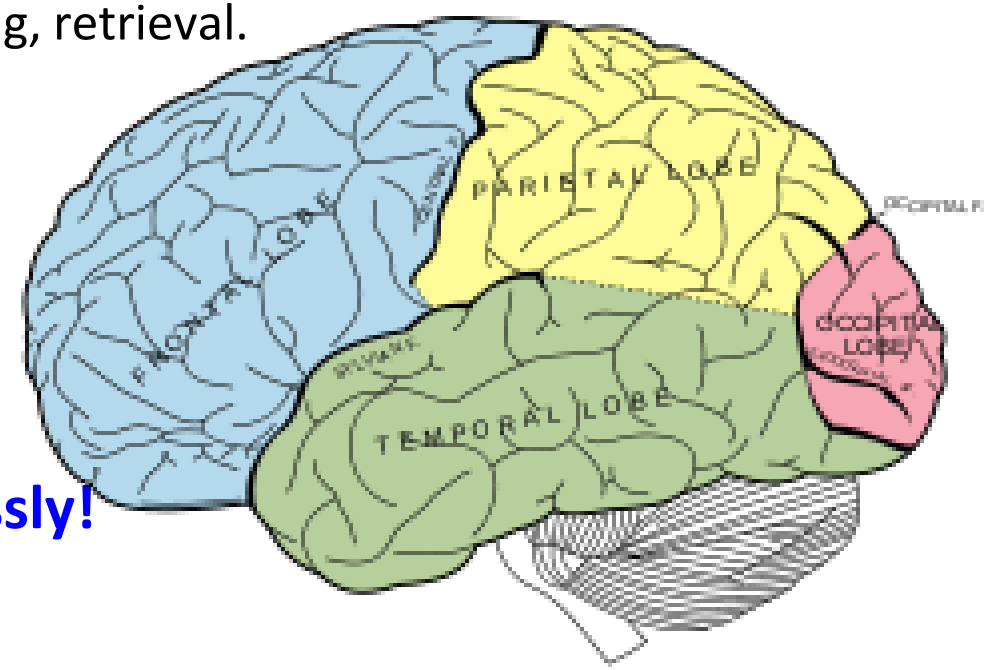
What is Biological Intelligence?

- Sensory processing:
  - Visual cortex.
  - Auditory cortex.
  - Somatosensory cortex.
- Motor cortex.
- Cognitive functions:
  - Memory.
  - Reasoning.
  - Executive control.
  - Learning.
  - Language.



What is Biological Intelligence?

- A mix of general-purpose and special-purpose algorithms.
- General-purpose:
  - Memory formation, updating, retrieval.
  - Learning new tasks.
- Special-purpose:
  - Recognizing visual patterns.
  - Recognizing sounds.
  - Learning language.
- **All are integrated seamlessly!**



What is AI?

What is AI?

- Some answers:
  - Modeling human cognition using computers.
  - Studying problems that others don't know how to solve.
  - Cool stuff!
    - Game playing, machine learning, data mining, speech recognition, computer vision, web agents, robots.
  - Useful stuff!
    - Medical diagnosis, fraud detection, genome analysis, object identification, space shuttle scheduling, information retrieval.

- Solving AI is potentially the **meta-solution** to **all problems!**

What is AI?

Working definition:

- Developing models and algorithms that can produce rational behaviors in response to incoming stimulus and information.

What is AI?

Human intelligence:

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- Motor cortex.
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  - Memory.
  - Reasoning.
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  - Learning.
  - Language.

What is AI?

Human intelligence:		**Artificial Intelligence:**
• Sensory processing:		
• Visual cortex	➔	Computer vision
• Auditory cortex	➔	Signal/speech processing
• Somatosensory cortex	➔	Haptics
• Motor cortex	➔	Robotics
• Cognitive functions		
• Memory	➔	Knowledge representation
• Reasoning	➔	Search, inference
• Executive control	➔	Planning, decision-making
• Learning	➔	Model learning
• Language	➔	Language understanding

What is AI?

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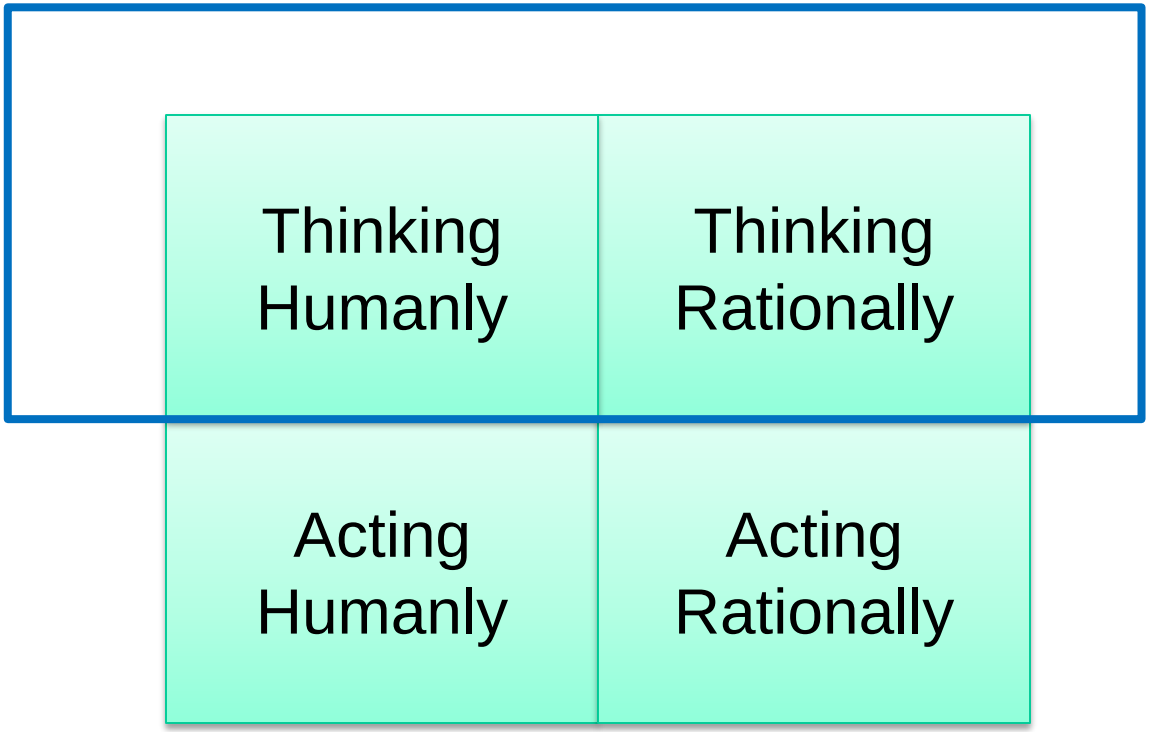
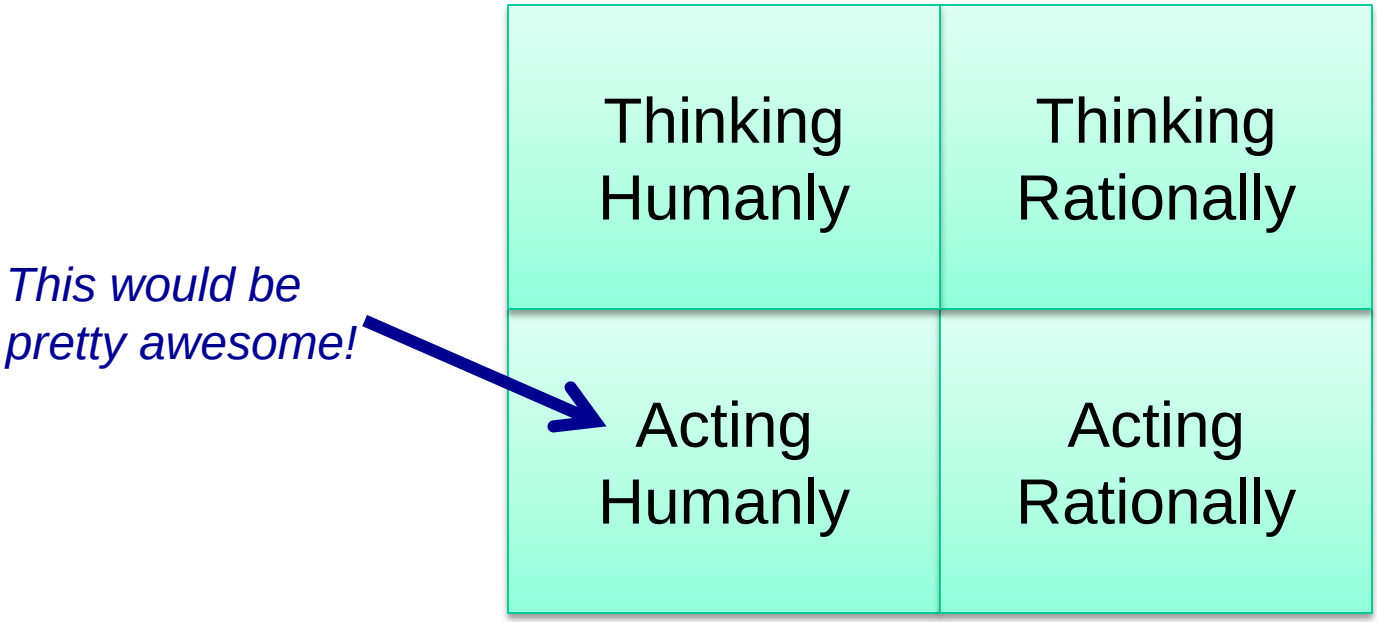
Different Goals of AI

What is one major obstacle to investigating these goals?



Different Goals of AI

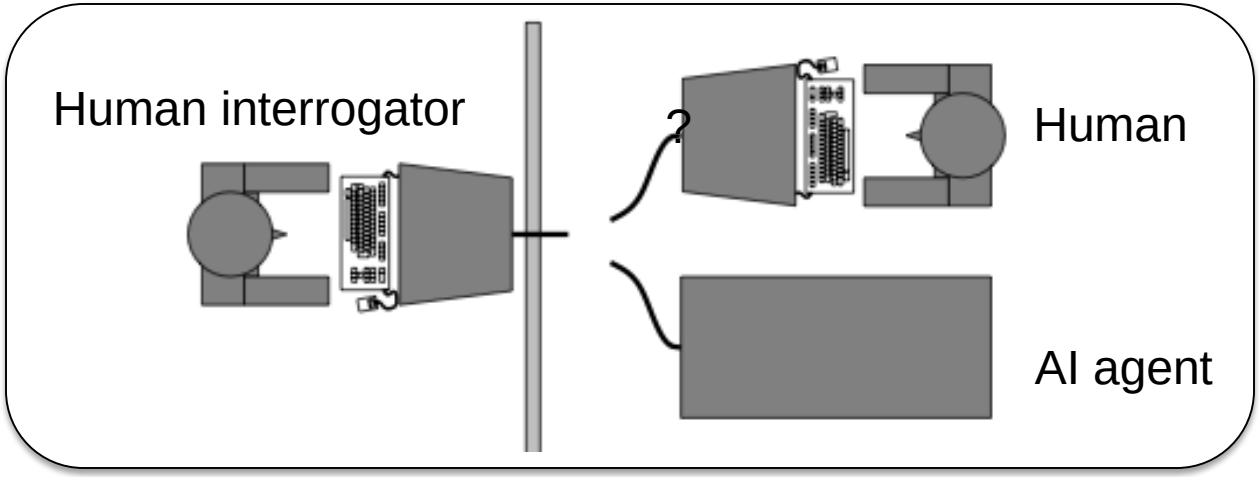


Acting Humanly

- AI is about duplicating what the (human) brain DOES.
- Alan Turing (1912-1954) had interesting thoughts about this.

Can a machine think? -> If it could, how would we tell?

Turing (1950): "Computing machinery and intelligence"



An operator interacts with either the human or the AI agent.
Can he correctly guess which one?

Turing's Prediction

- By 2000, a machine would have a 30% chance of fooling a lay person for 5 minutes.
  - Aside: this actually happened recently: http://www.bbc.com/news/technology-27762088

- Suggested major components of AI:
  - Knowledge representation, automated reasoning, language understanding, machine learning

Turing's Prediction

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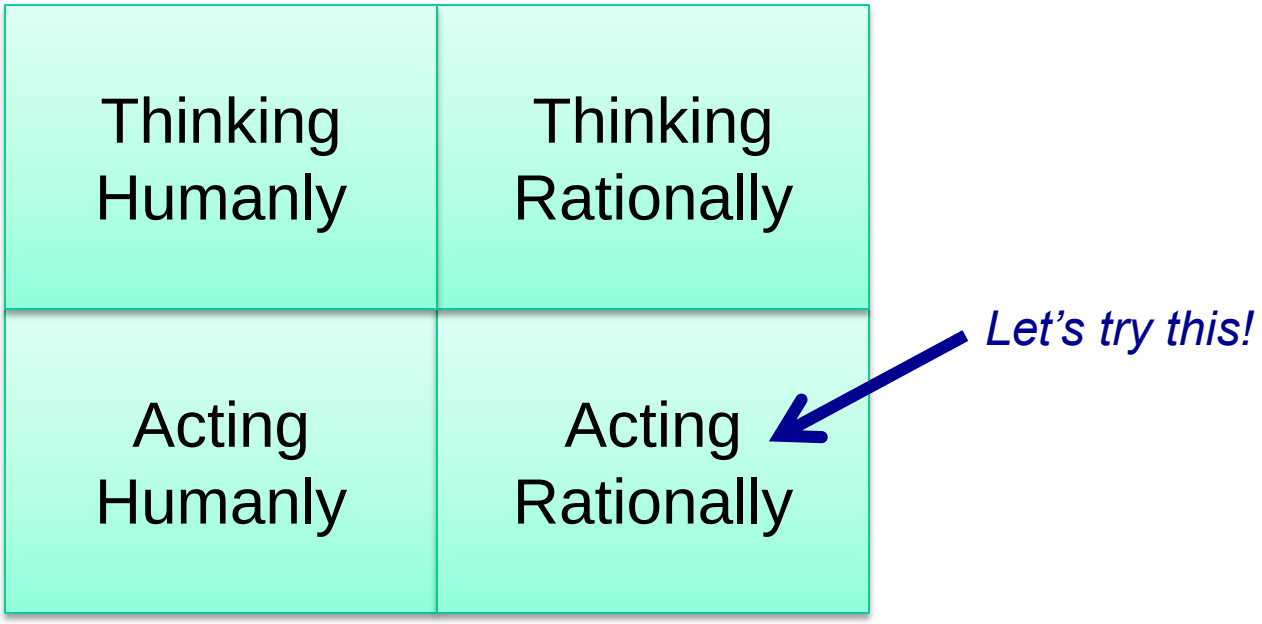
But here's a thought: We succeeded in building "flying machines" when we stopped trying to imitate birds, and started learning about aerodynamics.

Different Goals of AI



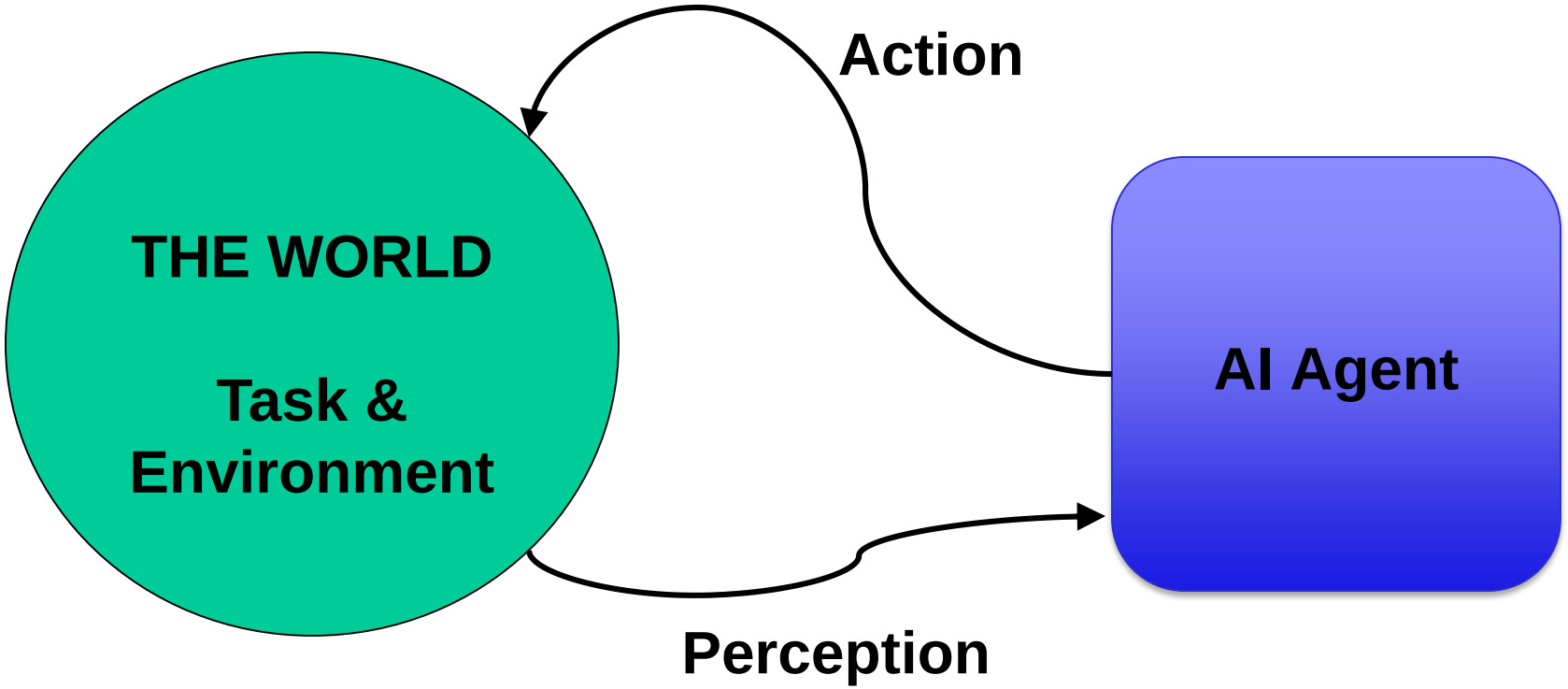
Acting Rationally

- Rational behaviour = doing the “right” thing.

- Doing what is expected to **maximize goal achievement**, given the **available information** and **available resources**.
  - Does not necessarily require thinking (e.g. blinking reflex).
  - But in many cases, thinking serves rational behaviour.

<u>This is the flavour of AI we will focus on.</u>

Big Picture



Rational Agents

- This course is about designing **rational agents**.
  - An agent is an entity that **perceives** and **acts**.
  - Goal: Learn a function mapping *percept histories* to *actions*:

    $f : P^h \rightarrow A$
- A rational agent implements this function such as to maximize performance.
  - Performance measures: goal achievement, resource consumption, ...

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- A rational agent implements this function such as to maximize performance.
  - Performance measures: goal achievement, resource consumption, ...
- Caveat: Many constraints can come into play (time, space, energy, bandwidth, …) which make perfect rationality unachievable.
- Objective: Find best function for given information and resources.

AI Beginnings

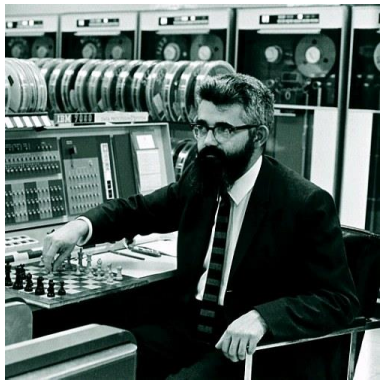
- ENIAC: First super-computer, created in 1946.
- Early work in 1950s:
  - Rosenblatt's perceptron
  - Samuel's checkers player

Dartmouth Conference (1956)

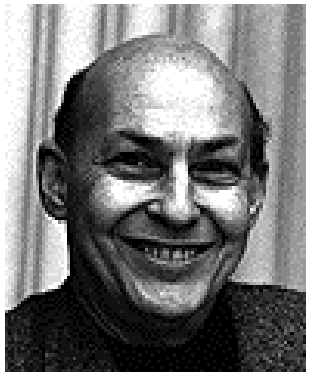
"We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves."

Dartmouth Conference (1956)

- Some of the attendees:
  - **John McCarthy**: LISP, time-sharing, application of logic to reasoning
  - **Marvin Minsky**: popularized neural networks and showed their limits, introduced slots and frames
  - **Claude Shannon**: information theory, juggling machine
  - **Allen Newell** and **Herb Simon**: bounded rationality, general problem solver, SOAR



- The meeting coined the term "**artificial intelligence**"



Early AI Hopes and Dreams

- Make programs that exhibit similar signs of intelligence as people: **prove theorems, play chess, have a conversation.**

- Logical reasoning was key.
- Learning from experience was considered important.
- The research agenda was geared towards building general problem solvers.

- There was a lot of hope that natural language could be easily understood and processed.

AI Downswings

- Early successes did not scale up!
  - Demos were impressive, but only worked in a narrow domain
  - e.g., Machine translation for general texts

1966	Perceived failure of machine translation
1973, 1974	Major cut in AI research funding
1987-1993	"AI Winter": many companies working in AI fail

- Much progress actually made in this period, but overpromising of results led to disappointments

Recent AI: Math to the Rescue!

- Heavy use of probability theory, decision theory, statistics.
- Trying to solve **specific problems** rather than aim for general reasoning.
- AI today is a collection of sub-fields:
  - Perception and computer vision.
  - Natural language understanding.
  - Robotics
  - Etc.
- Reasoning is now the part named "AI".
- A lot of progress was made in this way!
- Some recent efforts try to put all this together

AI system (1997): Chess playing

IBM Deep Blue defeats Garry Kasparov.

- Perception: advanced features of the board.
- Actions: choose a move.
- Reasoning: search and evaluation of possible board positions.

http://www-03.ibm.com

AI system (2008): Poker playing

University of Alberta's Polaris defeats some of the world's best online pros.

- One variety of poker: Heads-up limit Texas Hold'em (two players, limited betting amounts)
- Perception: features of the game.
- Actions: choose a move.

Match Number	Player	Amount Won	Player	Amount Won	Difference	Result
Remote 1	Matt Hawrilenko	+$199500	IJay Palansky	-$174000	+$25500	Humans Win
Remote 2	Nick Grudzien	-$2000	Kyle Hendon	-$118000	-$120000	Polaris Wins
Live 1	Nick Grudzien	-$42000	Kyle Hendon	+$37000	-$5000	Draw
Live 2	Rich McRoberts	+$89500	Victor Acosta	-$39500	+$50000	Humans Win
Live 3	Mark Newhouse	+$251500	IJay Palansky	-$307500	-$56000	Polaris Wins
Live 4	Matt Hawrilenko	-$60500	IJay Palansky	-$29000	-$89500	Polaris Wins

http://poker.cs.ualberta.ca/

AI system (2011): Jeopardy!

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Technology / Computers

Top 100 Stories of 2011 #3: A Supercomputer Wins Jeopardy!

When IBM's game-playing computer trounced two trivia experts, its victory was hailed as a landmark for intelligent machines. A Jeopardy! champ explains why the real winners were humans.

by Leeaundra Keany

From the January-February special issue; published online for subscribers only on December 29, 2011

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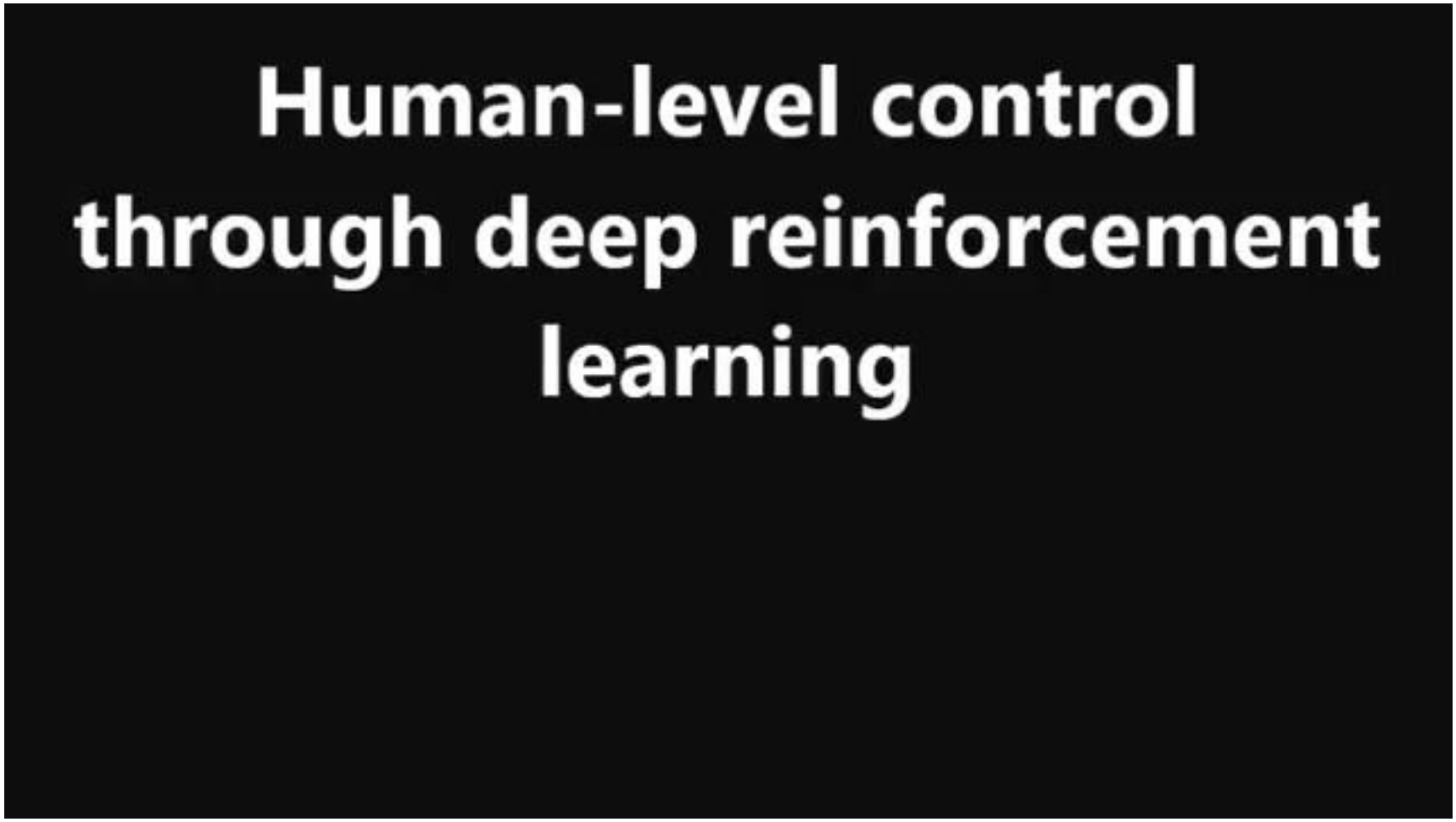
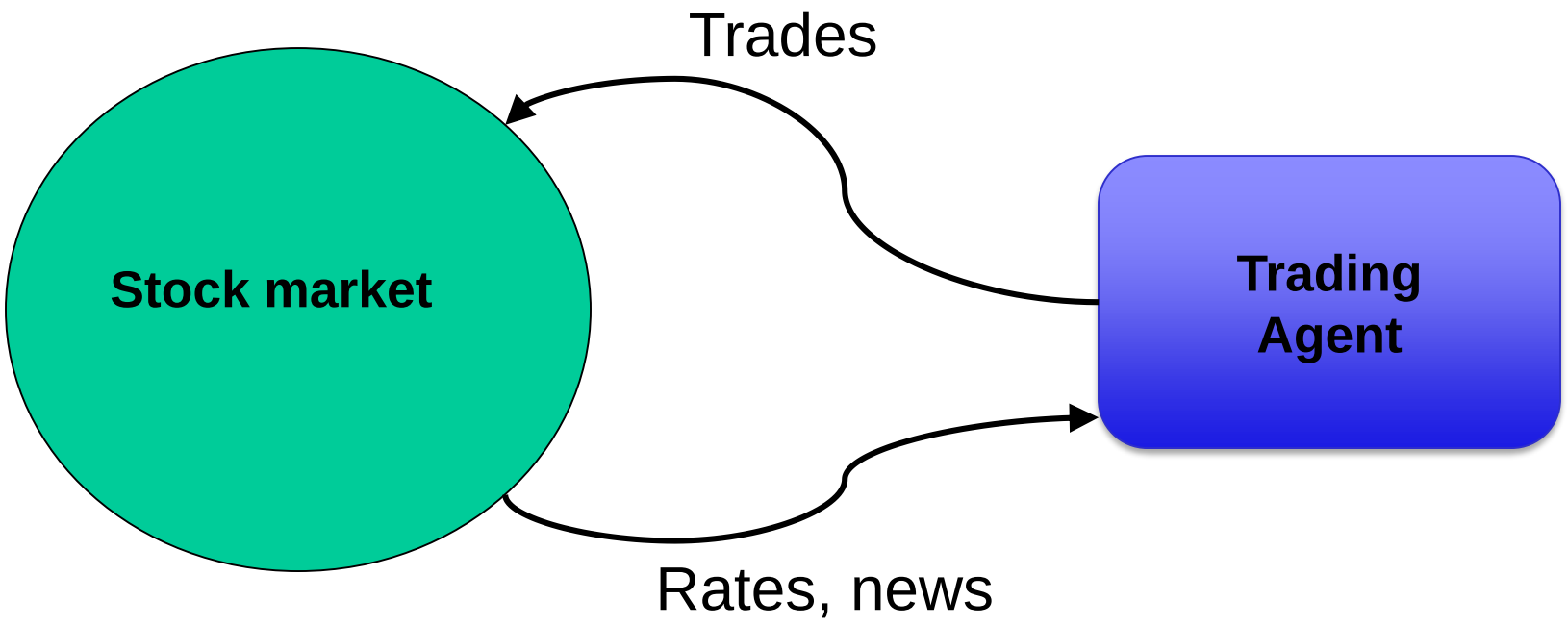
IBM's Watson computer system, powered by IBM POWER7, competes against Jeopardy!'s two most successful and celebrated contestants -- Ken Jennings and Brad Rutter.

AI system (2015): Atari



AI Meets Markets

- Trading agent competition (2002-2012):
  http://www.sics.se/tac/



AI Meets Markets

Algorithms Take Control of Wall Street

By Felix Salmon and Jon Stokes ✉ December 27, 2010 | 12:00 pm | Wired January 2011

Today Wall Street is ruled by thousands of little algorithms, and they've created a new market—volatile, unpredictable, and impossible for humans to comprehend.
Photo: Mauricio Alejo

AI Revolution

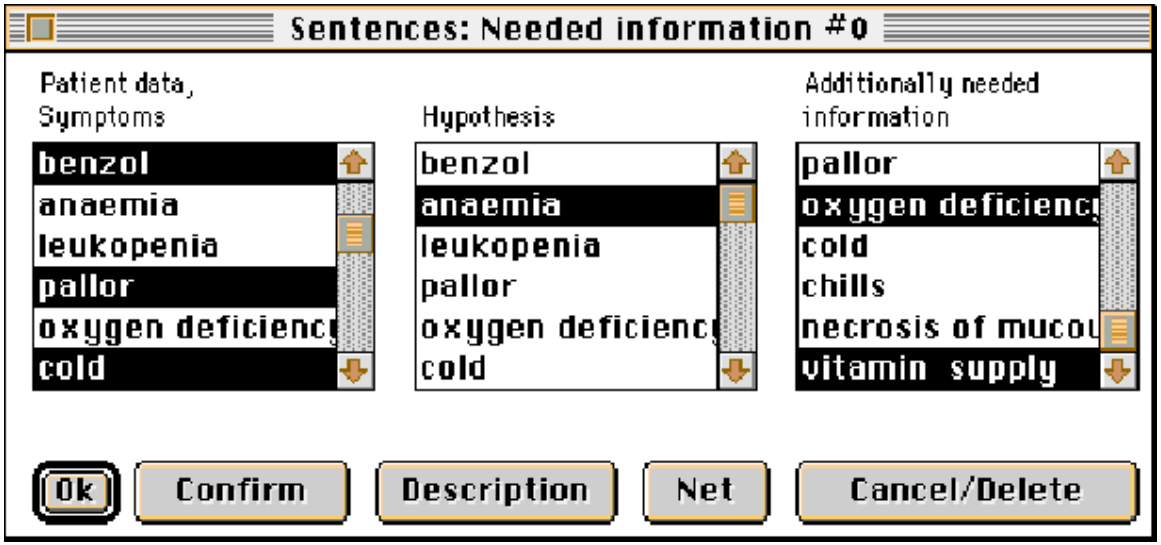
The AI Revolution Is On
AI Autos: Leave the Driving to Us

Last spring, Dow Jones launched a new service called Lexicon, which sends real-time financial news to professional investors. This in itself is not surprising. The company behind *The Wall Street Journal* and Dow Jones Newswires made its name by publishing the kind of news that moves the stock market. But many of the professional investors subscribing to Lexicon aren't human—they're algorithms, the lines of code that govern an increasing amount of global trading activity—and they don't read news the way humans do. They don't need their information delivered in the form of a story or even in sentences. They just want data—the hard, actionable information that those words represent.

AI system (1992): Medical diagnosis

Pathfinder (D. Heckerman, Microsoft Research)

- Perception: symptoms, test results.
- Actions: suggest tests, make diagnosis.
- Reasoning: Bayesian inference, machine learning, Monte-Carlo simulation.

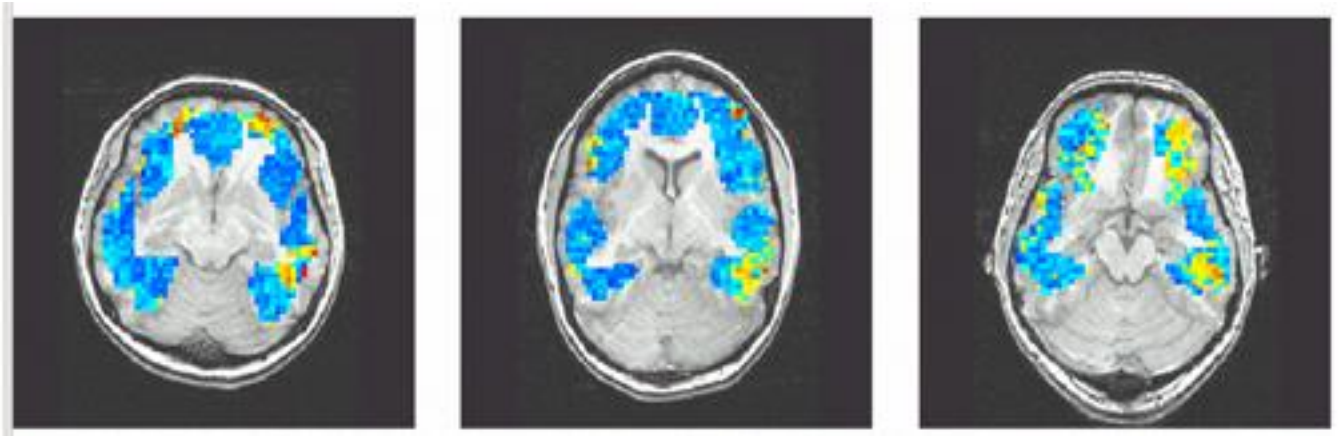


http://lls.informatik.uni-oldenburg.de/dokumente/1996/96_icls/icls_96_5.gif

AI system (2008): Reading the Mind

Brain Image Analysis (T. Mitchell, CMU)

- Perception: brain imaging using fMRI technology.
- Actions: detect which word (e.g. “hammer”, “apartment”, …) is being read by the human subject.
- Reasoning: statistical machine learning.

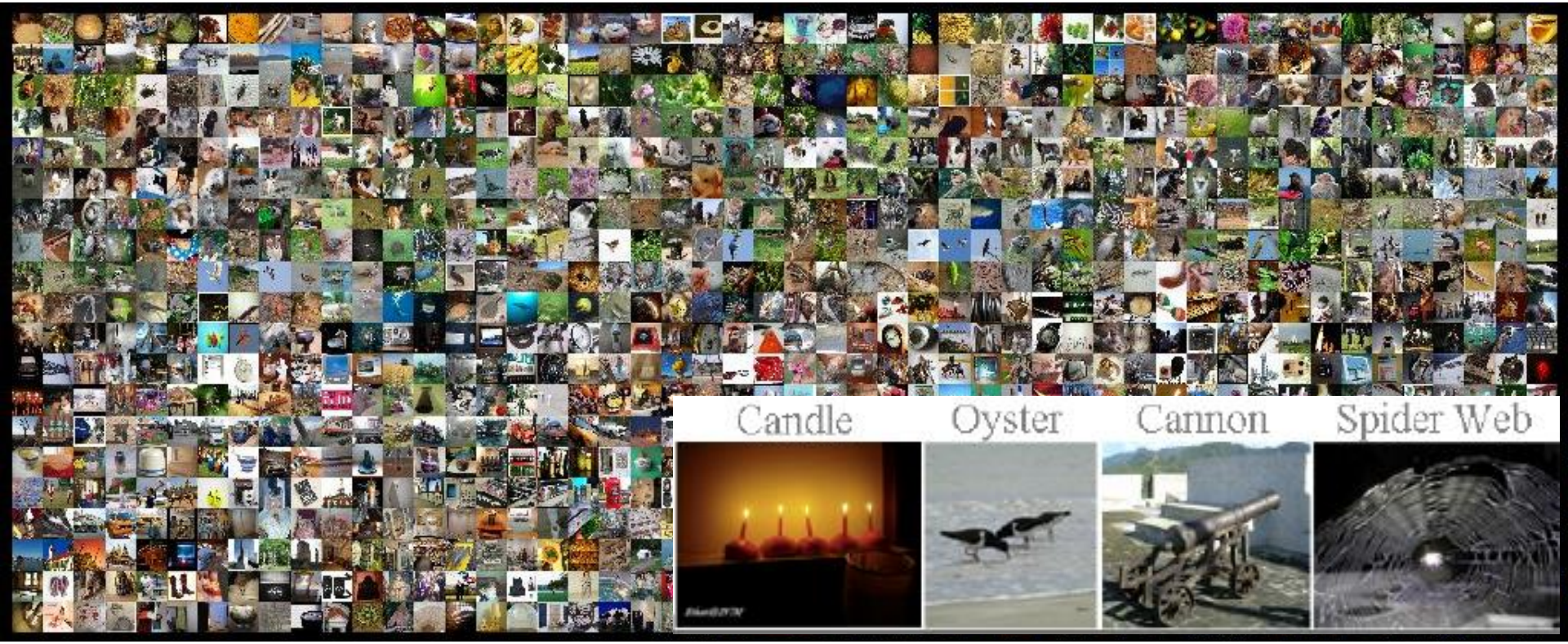


http://www.cs.cmu.edu/afs/cs/project/theo-73/www/index.html

AI system (2015): Object recognition

ImageNet Large Scale Visual Recognition Challenge *http://image-net.org*

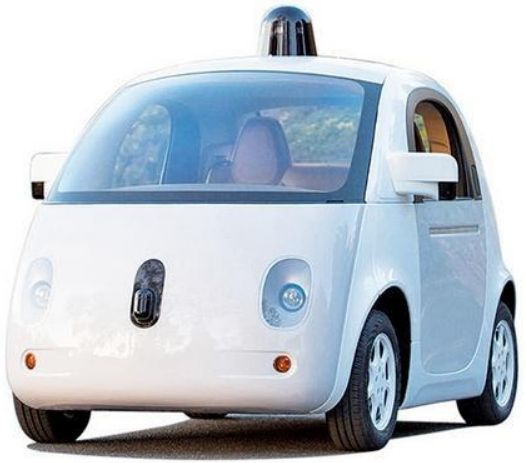
- Image database with 1000 object categories, hundreds of example images for each class, over 1 million images in total.
- Current best results: ~5% classification error (top 5 categories).



AI system (2014): City driving

Google cars have logged over 700,000 miles in autonomous mode with almost no accidents.

- Sensors and actuators similar to Stanley (GPS, 3D laser point cloud, cameras, odometry)
- Significant prior knowledge: City of Mountain View (12-square-mile) is fully mapped at high resolution.
- Accidents that have occurred **due to human error in the other vehicle**



AI system (2016): Amazon Echo

- Consumer-grade AI for <$200 US!

Amazon Echo - Black

Amazon

49,187 customer reviews | 1000+ answered questions

#1 Best Seller in Home Audio Speakers

Price: $179.99 & **FREE Shipping**. Details

In stock on January 25, 2017.

Order it now.

Ships from and sold by Amazon Digital Services LLC. Gift-wrap available.

Color: **Black**

$179.99 $179.99

- Plays all your music from Amazon Music, Spotify, Pandora, iHeartRadio, TuneIn, and more using just your voice
- Fills the room with immersive, 360° omni-directional audio
- Allows hands-free convenience with voice-control
- Hears you from across the room with far-field voice recognition, even while music is playing
- Answers questions, reads audiobooks and the news, reports traffic and weather, gives info on local businesses, provides sports scores and schedules, and more using the Alexa Voice Service
- Controls lights, switches, and thermostats with compatible WeMo, Philips Hue, Samsung SmartThings, Wink, Insteon, Nest, and ecobee smart home devices
- Always getting smarter and adding new features, plus thousands of skills like Uber, Domino's, and more

Jump to: Key features | Technical details

AI and the Web

- **Google:** 3.5 billion searches per day.
- **Facebook**: 2 billion photos uploaded every day. 700 engineers building machine learning algorithms to analyze the data.
- **YouTube**: 300 hours of video uploaded every minute.
- **Baidu**: 500 million page views per day
- **Flickr**: 2 million photos uploaded every day.
- **Twitter**: 500 million tweets sent per day.

Final comments

- Come to class! Come prepared!
- Be willing to learn and work hard!

- For next class:
  - Read Chapters 1-3 of Russell & Norvig.
  - Review the course syllabus.

- Questions?