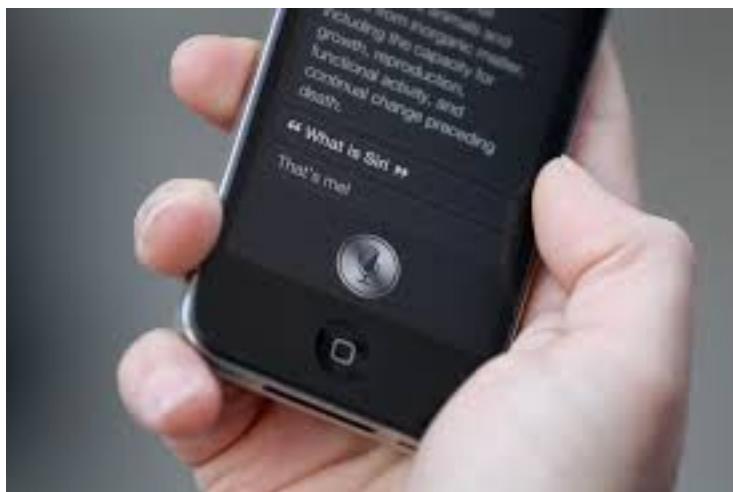


# Intro to Artificial Intelligence

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# Today

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- Who am I?
- Course overview
- What is AI?
- State of the art in AI today
- Topics covered in the course

# Who am I?

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## Sanja Lazarova-Molnar, PhD

- Associate Professor at SDU, Software Engineering
- PhD in Computer Science, 2005, University of Magdeburg in Germany
- Specialization in Modeling and Simulation
  - Developed and implemented a new simulation method: The Proxel-based method
  - Implemented and used in the simulation tool by DaimlerChrysler
- Teaching since 2002
  - Artificial Intelligence since 2010

# Research Interests

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## Previously:

- Reliability Modeling of Nano-Circuits
- Machine Learning in Bioinformatics (**Genetic Algorithms and Support Vector Machines-based**)
- Modeling and Simulation for Design of Evolving Project Schedules

## Current Research Interests

- Modeling and Simulation of Stochastic Systems
- Decision Support Systems (**Simulation and AI methods**)
- Reliability Modeling and Analysis
- Fault Detection and Diagnosis (**AI and ML methods**)
- Collaborative Data Analytics (**AI**)
- Data-driven Modeling and Simulation (**AI**)

current  
focus

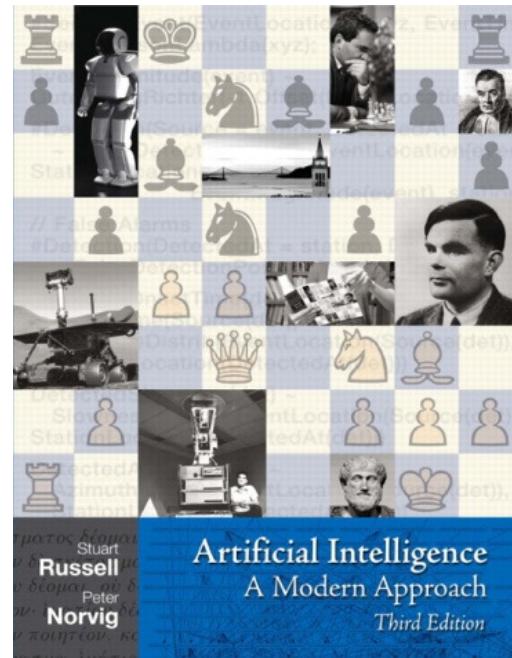
# Who is this course for?

---

- An introductory survey of AI techniques for students who have not previously had an exposure to this subject and want to improve their programming skills
- Goals:
  - Learn and understand the AI methods so you can apply them to real-world problems
  - Learn Python as the “AI programming language”
    - Not a must, just an offer!

# Basic Info

- **Textbook:**  
S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, Prentice Hall, 3<sup>rd</sup> ed.  
<http://aima.cs.berkeley.edu/>



# Programming skills

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Reminder: Students are expected to know how to program.

Programming examples will be in python – extremely useful language to know, used in many current AI courses, not too hard to pick up given previous programming experience.

Another choice of programming language is Java, but we only provide programming help with Python, so you are encouraged to learn it for your benefit.

# Lab Instructors

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Lasse Hunniche Klevang, MSc Student

Mads Christopher Norby Christophersen, MSc Student

Jonas Friederich, PhD Student

Use your lab time wisely and ask questions if you have problems!

# Exam Info

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- Written exam: Multiple choice
- Prerequisite: submission of a complete exercise and homework folder, structured with folders by lectures
- All exercise/homework need to be completed/solved
- No notes allowed
- 10-20% of exam questions will be homework and exercise related, asking you to run the code to answer questions
- Permitted IDEs for the exam
  - JetBrains
  - Visual Studio
  - **Only these two IDEs will be allowed in the exam!**

# IEEE Ranking of the Top Programming Languages of 2021

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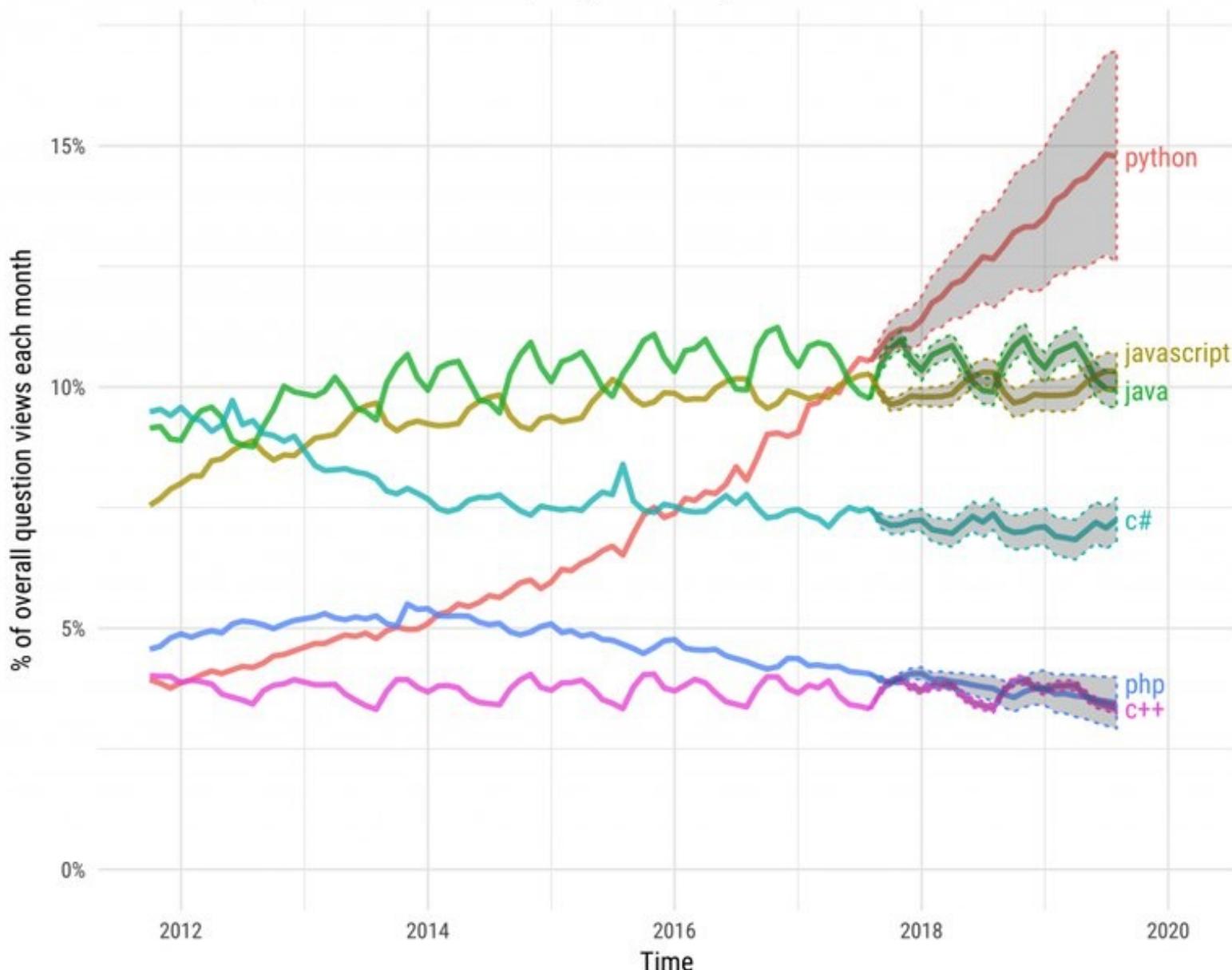
Why  
Python?

[source](#)

Language Rank	Types	Spectrum Ranking
1. Python		100.0
2. C		99.7
3. Java		99.5
4. C++		97.1
5. C#		87.7
6. R		87.7
7. JavaScript		85.6
8. PHP		81.2
9. Go		75.1
10. Swift		73.7

## Projections of future traffic for major programming languages

Future traffic is predicted with an STL model, along with an 80% prediction interval.

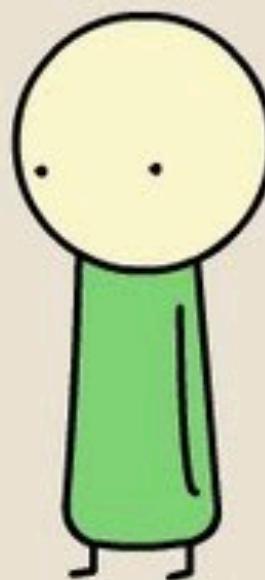


# Why Python?

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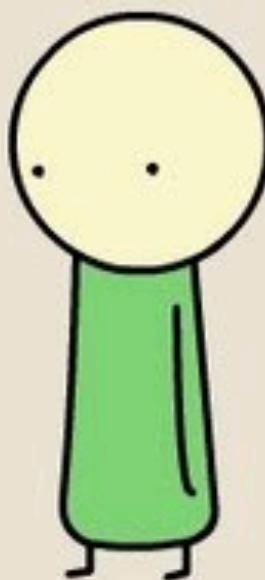
# PYTHON

THIS IS PLAGIARISM.  
YOU CAN'T JUST "IMPORT ESSAY."



# JAVA

I'M TWO PAGES IN AND I STILL  
HAVE NO IDEA WHAT YOU'RE SAYING.



# Python vs. Java

---

```
public class Hello {  
    public static void main(String[] args){  
        System.out.println("Hello world");  
    }  
}  
  
print "Hello world";
```

# More on this....

---

- <http://datavirtualizer.com/popularity-vs-productivity-vs-performance/>
- <http://blogs.perceptionsystem.com/infographic/java-vs-python-programming-language-productive/>
- Python-preferred language for AI programming
- Python Tutorial
  - <http://www.learnpython.org/>

# Academic integrity policy

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- Feel free to discuss assignments with each other, but coding should be done individually
- Feel free to incorporate code or tips you find on the Web, provided this doesn't make the assignment trivial

# What is AI?

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Some possible definitions from the textbook:

**1. Thinking humanly**

**2. Acting humanly**

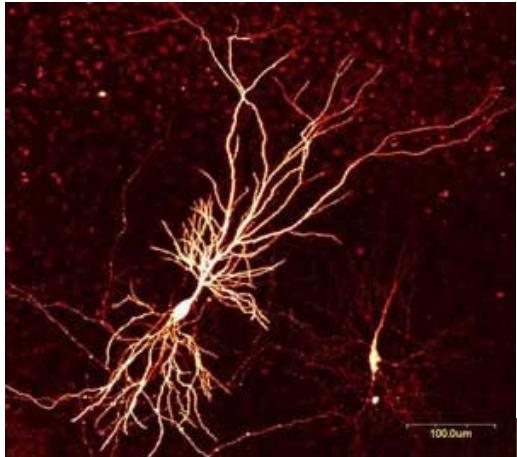
**3. Thinking rationally**

**4. Acting rationally**

# AI definition 1: Thinking humanly

---

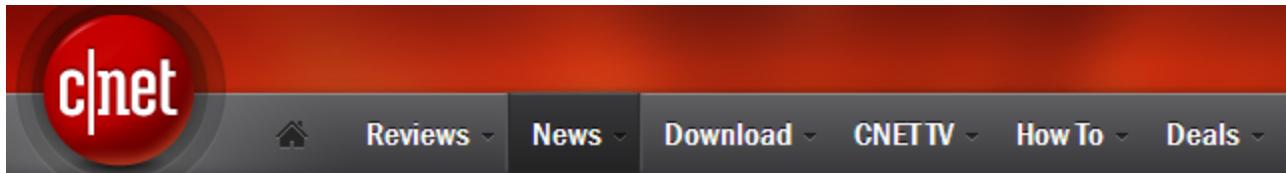
- Need to study the brain as an information processing machine: cognitive science and neuroscience



# AI definition 1: Thinking humanly

---

- Can we build a brain?



CNET > News > Crave > Fujitsu supercomputer simulates 1 second of brain activity

## Fujitsu supercomputer simulates 1 second of brain activity

Harnessing more than 82,000 processors on the world's fourth-ranked supercomputer, scientists run an experiment that represents 1 percent of human brain activity.

The simulation involved 1.73 billion virtual nerve cells connected by 10.4 trillion synapses and was run on Japan's K computer, which was ranked the fastest in the world in 2011.

It took the Fujitsu-built K about 40 minutes to complete a simulation of one second of neuronal network activity in real time, according to Japanese research institute RIKEN, which runs the machine.

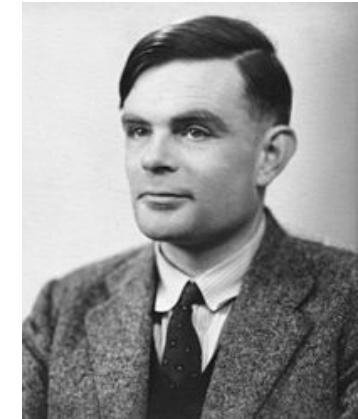
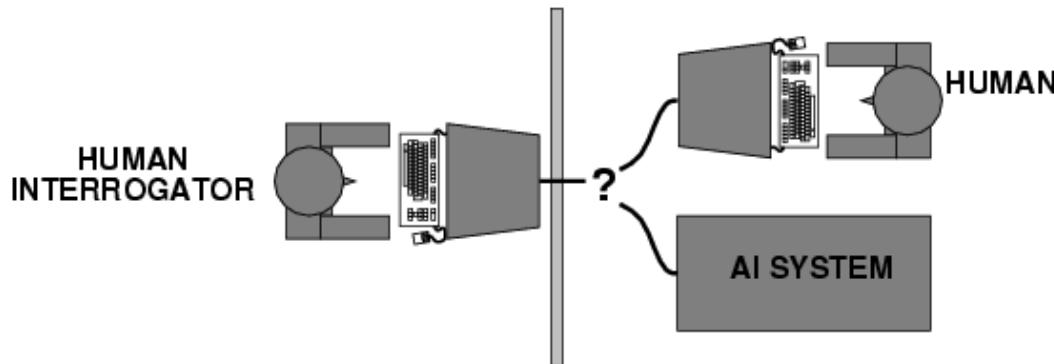
Brain  
Computation  
Report

“Even with a million processors, we can only approach 1 percent of the scale of the human brain, and that's with a lot of simplifying assumptions”

# AI definition 2: Acting humanly

---

- The Turing Test

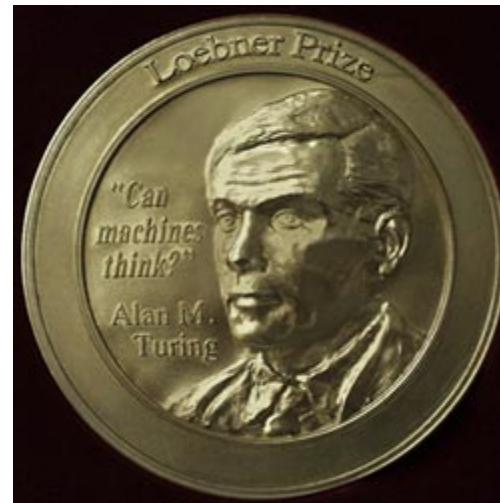


- What capabilities would a computer need to have to pass the Turing Test?
  - Natural language processing
  - Knowledge representation
  - Automated reasoning
  - Machine learning

# The Turing Test

---

- Turing predicted that by the year 2000, machines would be able to fool 30% of human judges for five minutes
- Loebner prize
  - 2008 competition: each of 12 judges was given five minutes to conduct simultaneous, split-screen conversations with two hidden entities (human and chatterbot). The winner, Elbot of Artificial Solutions, managed to fool three of the judges into believing it was human [[Wikipedia](#)].
  - <http://www.paulmckevitt.com/loebner2013/testing/index.html>



# Turing Test: Criticism

---

- Success depends on deception!
- Chatbots can do well using “cheap tricks”
  - First example: [ELIZA](#) (1966)
  - Latest – Mitsuku (for the 5<sup>th</sup> time, Siri was ranked 14<sup>th</sup> when in 2013 unofficially entered):  
<https://medium.com/pandorabots-blog/mitsuku-wins-loebner-prize-2018-3e8d98c5f2a>
  - [http://aisb.org.uk/media/files/LoebnerPrize2018/Transcripts\\_2018.pdf](http://aisb.org.uk/media/files/LoebnerPrize2018/Transcripts_2018.pdf)
  - <http://www.square-bear.co.uk/mitsuku/turing/>

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*The trophy would not fit in the brown suitcase because it was so small.*

*What was so small?*

- *The trophy*
- *The brown suitcase*

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*The trophy would not fit in the brown suitcase because it was so **large**.*

*What was so **large**?*

- *The trophy*
- *The brown suitcase*

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*The large ball crashed right through the table because it was made of styrofoam.*

*What was made of styrofoam?*

- *The large ball*
- *The table*

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*The large ball crashed right through the table because it was made of steel.*

*What was made of steel?*

- *The large ball*
- *The table*

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*The sack of potatoes had been placed below the bag of flour, so it had to be moved first.  
What had to be moved first?*

- *The sack of potatoes*
- *The bag of flour*

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*The sack of potatoes had been placed **above** the bag of flour, so it had to be moved first.  
What had to be moved first?*

- *The sack of potatoes*
- *The bag of flour*

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*Sam tried to paint a picture of shepherds with sheep, but they ended up looking like golfers.  
What looked like golfers?*

- *The shepherds*
- *The sheep*

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*Sam tried to paint a picture of shepherds with sheep, but they ended up looking like rabbits.  
What looked like rabbits?*

- *The shepherds*
- *The sheep*

# A better Turing test?

---

Multiple choice questions that can be easily answered by people but cannot be answered by computers using “cheap tricks”:

*Sam tried to paint a picture of shepherds with sheep, but they ended up looking like rabbits.  
What looked like rabbits?*

- *The shepherds*
- *The sheep*

# A better Turing test?

---

## Advantages over standard Turing test

- Test can be administered and graded by machine
- Does not depend on human subjectivity
- Questions cannot be evaded using verbal dodges
- Questions can be made “Google-proof”

# AI definition 3: Thinking rationally

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Idealized or “right” way of thinking

- **Logic:** patterns of argument that always yield correct conclusions when supplied with correct premises  
“Socrates is a man; all men are mortal; therefore Socrates is mortal.”
- **Logicist approach to AI:** describe problem in formal logical notation and apply general deduction procedures to solve it
- Problems with the logicist approach
  - Computational complexity of finding the solution
  - Describing real-world problems and knowledge in logical notation
  - Dealing with uncertainty
  - A lot of “rational” behavior has nothing to do with logic

# AI definition 4: Acting rationally

---

- A *rational agent* acts to optimally achieve its goals
- Goals are application-dependent and are expressed in terms of the **utility of outcomes**
- Being rational means **maximizing your (expected) utility**

# What are some successes of AI today?

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# IBM Watson

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- <http://www.research.ibm.com/deepqa/>
- Watch!  
<https://www.youtube.com/watch?v=r7E1TJ1HtM0>
- [NY Times article](#)
- [Trivia demo](#)
- [YouTube video](#)

# Self-driving cars

## Autonomous Driving

Google's modified Toyota Prius uses an array of sensors to navigate public roads without a human driver. Other components, not shown, include a GPS receiver and an inertial motion sensor.

### LIDAR

A rotating sensor on the roof scans more than 200 feet in all directions to generate a precise three-dimensional map of the car's surroundings.

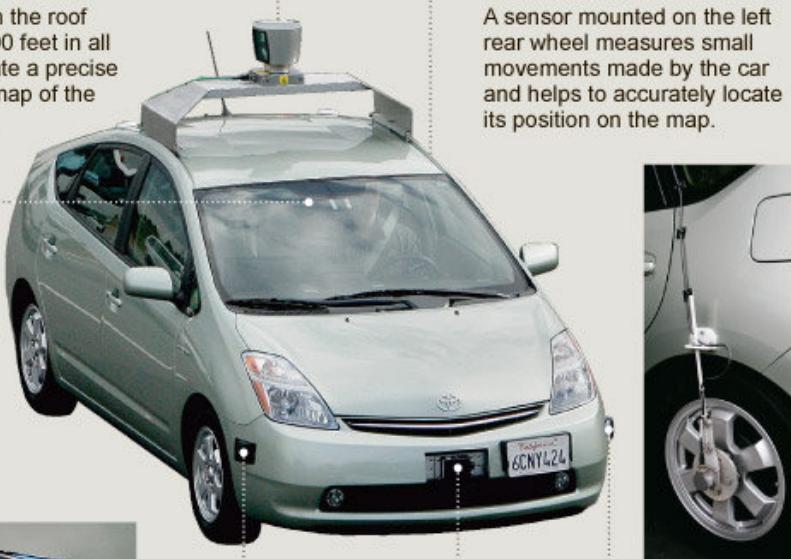
### VIDEO CAMERA

A camera mounted near the rear-view mirror detects traffic lights and helps the car's onboard computers recognize moving obstacles like pedestrians and bicyclists.



### POSITION ESTIMATOR

A sensor mounted on the left rear wheel measures small movements made by the car and helps to accurately locate its position on the map.



Source: Google

THE NEW YORK TIMES; PHOTOGRAPHS BY RAMIN RAHIMIAN FOR THE NEW YORK TIMES

Just google news  
on self-driving cars!  
(but also [this](#))

- <https://www.telegraph.co.uk/technology/2019/02/06/rapid-roll-driverless-cars-uk-roads-should-have-us-worried/>
- <https://www.fastcompany.com/90300056/self-driving-cars-will-never-be-moral-lets-stop-pretending-otherwise>

# Natural Language

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- Speech technologies

- [Google voice search](#)
- [Apple Siri](#)

“ What is the meaning of life ”  
Try and be nice to people, avoid eating fat, read a good book every now and then, get some walking in, and try to live together in peace and harmony with people of all creeds and

“ Siri why are you so great ”  
I am what I am.

- Machine translation

- [translate.google.com](#)
- [Comparison of several translation systems](#)

Source	The Original Text	Human Translation	Google Translate
 French "Le Petit Prince" ("The Little Prince") By Antoine de Saint-Exupéry	<p>Le premier soir je me suis donc endormi sur le sable à mille milles de toute terre habitéée. J'étais bien plus isolé qu'un naufragé sur un radeau au milieu de l'océan. Alors vous imaginez ma surprise, au lever du jour, quand une drôle de petite voix m'a réveillé. Elle disait: -S'il vous plaît... dessine-moi un mouton!</p>	<p>On the first night, I fell asleep on the sand, a thousand miles from any human habitation. I was far more isolated than a shipwrecked sailor on a raft in the middle of the ocean. So you can imagine my surprise at sunrise when an odd little voice woke me up. It said: "Please ... draw me a sheep." - Wordsworth Children's Classics, 1995</p>	<p>The first night I went to sleep on the sand a thousand miles from any human habitation. I was more isolated than a shipwrecked sailor on a raft in the middle of the ocean. So imagine my surprise at daybreak, when a funny little voice woke me. She said: "If it pleases you ... draw me a sheep!"</p>

# Vision

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- OCR, handwriting recognition
- Face detection/recognition: many consumer cameras, Facebook
- Visual search: Google Goggles, search by image
  - Discontinued, Now Google Lens or Google Photos



Google Goggles In Action

Click the icons below to see the different ways Google Goggles can be used.

Landmark Book Contact Info. Artwork Places Wine Logo

Web Results

Terrazas de los Andes 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, 2000, 1999, 1998, 1997, 1996, 1995, 1994, 1993, 1992, 1991, 1990, 1989, 1988, 1987, 1986, 1985, 1984 ...  
<http://www.terrazasdelosandes.com/>

▶ manufacturer products      consumer products

Our Vision. Your Safety.

rear looking camera

forward looking camera

side looking camera

side looking camera

▶ EyeQ Vision on a Chip

▶ Vision Applications

Road, Vehicle, Pedestrian Protection and more

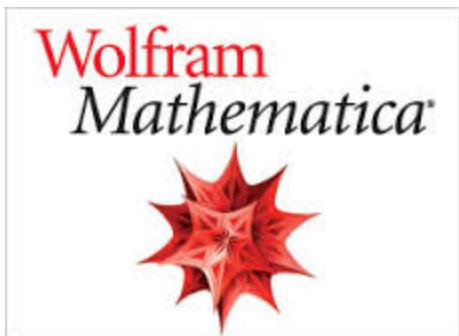
▶ AWS Advance Warning System

Google goggles  
labs

# Mathematics

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- In 1996, a computer program written by researchers at Argonne National Laboratory proved a mathematical conjecture unsolved for decades
  - [NY Times story](#): “[The proof] would have been called creative if a human had thought of it”
- Mathematical software:



$$\begin{aligned}\partial_r^2 u &= - \left[ E' - \frac{l(l+1)}{r^2} - r^2 \right] u(r) \\ e^{-2s} (\partial_s^2 - \partial_s) u(s) &= - [E' - l(l+1)e^{-2s} - e^{2s}] u(s) \\ e^{-2s} \left[ e^{\frac{1}{2}s} \left( e^{-\frac{1}{2}s} u(s) \right)'' - \frac{1}{4} u \right] &= - [E' - l(l+1)e^{-2s} - e^{2s}] u(s) \\ e^{-2s} \left[ e^{\frac{1}{2}s} \left( e^{-\frac{1}{2}s} u(s) \right)'' \right] &= - \left[ E' - \left( l + \frac{1}{2} \right)^2 e^{-2s} - e^{2s} \right] u(s) \\ v'' &= -e^{2s} \left[ E' - \left( l + \frac{1}{2} \right)^2 e^{-2s} - e^{2s} \right] v\end{aligned}$$

# Games

---

- IBM's Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
  - **1996: Kasparov Beats Deep Blue**  
“I could feel – I could smell – a new kind of intelligence across the table.”
  - **1997: Deep Blue Beats Kasparov**  
“Deep Blue hasn't proven anything.”
- In 2007, checkers was “solved” (though checkers programs had been beating the best human players for at least a decade before then)
  - [Science article](#)
- Google's AI has beat a human grandmaster at Go for the first time, [link](#)
- Latest: Google AI beats top human players at strategy game StarCraft II, [link](#)



# Logistics, scheduling, planning

---

- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people
- NASA's [Remote Agent](#) software operated the Deep Space 1 spacecraft during two experiments in May 1999
- In 2004, NASA introduced the [MAPGEN](#) system to plan the daily operations for the Mars Exploration Rovers

# Robotics

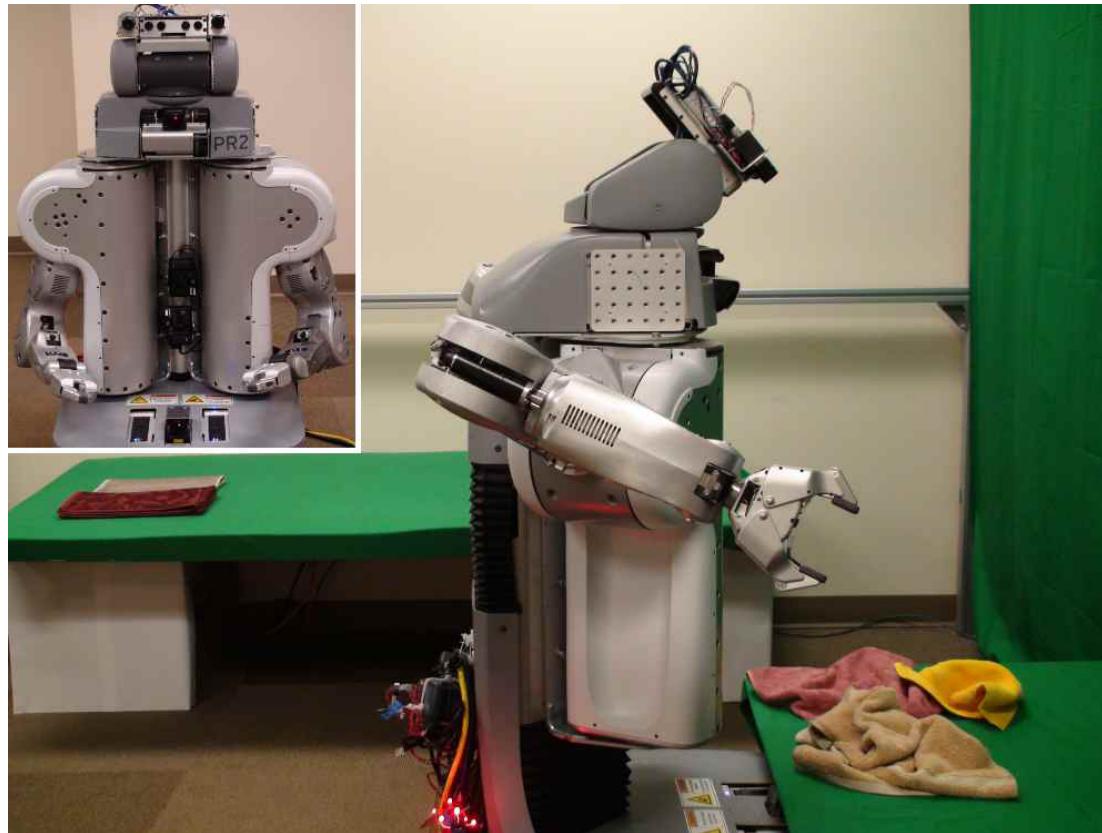
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- Mars rovers
- Autonomous vehicles
  - Self-driving cars
- Autonomous helicopters
- Drones
- Robot soccer
  - RoboCup
- Personal robotics
  - Humanoid robots
  - Robotic pets
  - Personal assistants
    - <https://www.youtube.com/watch?v=ve6VjJyfOg>
    - <https://www.youtube.com/watch?v=lNHjXWzDwIY>



# Towel-folding robot

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[YouTube Video](#)

- J. Maitin-Shepard, M. Cusumano-Towner, J. Lei and P. Abbeel, [Cloth Grasp Point Detection based on Multiple-View Geometric Cues with Application to Robotic Towel Folding](#), ICRA 2010
- [More clothes folding](#)

# Origins of AI: Early excitement

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1940s First model of a neuron (W. S. McCulloch & W. Pitts)

Cybernetics

1950s Turing Test

Perceptrons (F. Rosenblatt)

Computer chess and checkers (C. Shannon, A. Samuel)

Machine translation (Georgetown-IBM experiment)

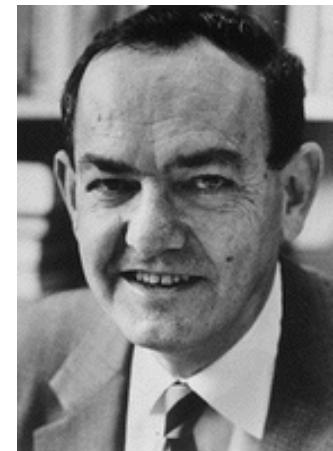
Theorem provers (A. Newell and H. Simon,  
H. Gelernter and N. Rochester)

1956 **Dartmouth meeting: “Artificial Intelligence” adopted**

# Herbert Simon, 1957

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*"It is not my aim to surprise or shock you – but ... there are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until – in a visible future – the range of problems they can handle will be coextensive with the range to which human mind has been applied. **More precisely: within 10 years a computer would be chess champion, and an important new mathematical theorem would be proved by a computer.**"*



- Simon's prediction came true – but forty years later instead of ten

# Harder than originally thought

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- 1966: Eliza chatbot (Weizenbaum)
  - “... mother ...” → “**Tell me more about your family**”
  - “**I wanted to adopt a puppy, but it’s too young to be separated from its mother.**”
- 1954: Georgetown-IBM experiment
  - Completely automatic translation of more than sixty Russian sentences into English
  - Only six grammar rules, 250 vocabulary words, restricted to organic chemistry
  - Promised that machine translation would be solved in three to five years (press release)
  - Automatic Language Processing Advisory Committee (ALPAC) report (1966): machine translation has failed
    - “**The spirit is willing but the flesh is weak.**” → “**The vodka is strong but the meat is rotten.**”

# History of AI: Taste of failure

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- Late 1960s      Machine translation deemed a failure  
                  Neural nets deprecated (M. Minsky and S. Papert, 1969)\*
- Early 1970s     Intractability is recognized as a fundamental problem
- Late 1970s      The first “[AI Winter](#)”

\*[A sociological study of the official history of the perceptrons controversy](#)

# History of AI to the present day

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- 1980s              Expert systems boom
- Late 1980s-        Expert system bust; the second “AI winter”
- Early 1990s
- Mid-1980s         Neural networks and back-propagation
- Late 1980s         Probabilistic reasoning on the ascent
- 1990s-Present      Machine learning everywhere
  - Big Data
  - Deep Learning

[History of AI on Wikipedia](#)

[AAAI Timeline](#)

[Building Smarter Machines: NY Times Timeline](#)

# What accounts for recent successes in AI?

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- Faster computers
  - The IBM 704 vacuum tube machine that played chess in 1958 could do about **50,000 calculations per second**
  - Deep Blue could do **50 billion calculations per second**  
– a million times faster!
- Dominance of statistical approaches, machine learning
- Big data
- Crowdsourcing

# To read home...

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Interesting read:

- Ray Kurzweil's Mind-Boggling Predictions for the Next 25 Years
  - <http://singularityhub.com/2015/01/26/ray-kurzweils-mind-boggling-predictions-for-the-next-25-years/>

# Course Topics (Tentative)

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## Tentative Course Plan

Lect. #	Topic	Chapter
1	Introduction to AI	1
2	Introduction to Python	-
3	Agents	2
4	Intro to Search / Uninformed Search	3.1 - 3.4
5	Informed Search	3.5 - 3.6
6	Local Search	4
7	Adversarial Search	5
8	Constraint Satisfaction Problems	6
9	Probability	13
10	Bayesian Networks	14
11	Hidden Markov Models	15.3 + Extra Materials
12	Review/ Intro to Machine Learning	18