

CS 1: Fall 2018

**Artificial Intelligence (AI)**  
**Adnan Darwiche**

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**<http://cs.ucla.edu/~darwiche>**



# **What is AI?**

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- ◆ A field of computer science concerned with understanding and building intelligent agents that can:
  - Perceive
  - Understand
  - Predict
  - Manipulate
  - Learn
- ◆ This is very hard, yet possible, quite useful and a lot of fun!
- ◆ Monolithic approach unnecessary for usefulness
- ◆ Hardware versus software (web) agents
- ◆ General versus task-specific intelligence

# **What is AI?**

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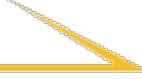
- ◆ **Broad goals of AI are shared with other disciplines, including philosophy, cognitive science (psychology) and neuroscience. Some key distinctions:**
  - **Understand versus build**
  - **Rational versus human-like**
- ◆ **Specific goals of AI are shared with other disciplines, including linguistics (perception), statistics (learning), and mathematical logic (understanding and prediction).**

# *The Turing Test*

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- ◆ Proposed by Alan Turing in 1950 as an operational test of intelligence: fool a human interrogator into believing the agent is a human. To pass the test, one needs:
  - Natural language processing
  - Knowledge representation
  - Automated reasoning
  - Machine learning
- ◆ Avoided physical interaction between interrogator and agent, excluding need for:
  - Computer vision
  - Robotics
- ◆ Rational versus human-like...

# The Turing Test



## Moving Beyond the Turing Test with the Allen AI Science Challenge

*Carissa Schoenick, Peter Clark, Oyvind Tafjord, Peter Turney, Oren Etzioni  
April 2016*

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Given recent successes in AI (e.g., AlphaGo's victory against Lee Sedol in the game of GO), it's become increasingly important to assess: how close are AI systems to human-level intelligence? This paper describes the Allen AI Science Challenge—an approach towards that goal which led to a unique Kaggle Competition, its results, the lessons learned, and our next steps.

### Measuring Artificial Intelligence

The famous Turing test developed by Alan Turing in 1950 proposes that if a system can exhibit question-answering behavior that is indistinguishable from that of a human during a conversation, that system could be considered intelligent. As the field of artificial intelligence grows, this approach to evaluating a system has become less and less appropriate or meaningful. Current systems have revealed just how gameable this assessment of AI can be, as some chatbots have improved in recent years to the point where one could argue a few of them could pass the Turing test [1][2]. As The New York Times' John Markoff puts it, "the Turing test is a test of human gullibility."

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# The Turing Test

## Moving Beyond the Turing Test with the Allen AI Science Challenge

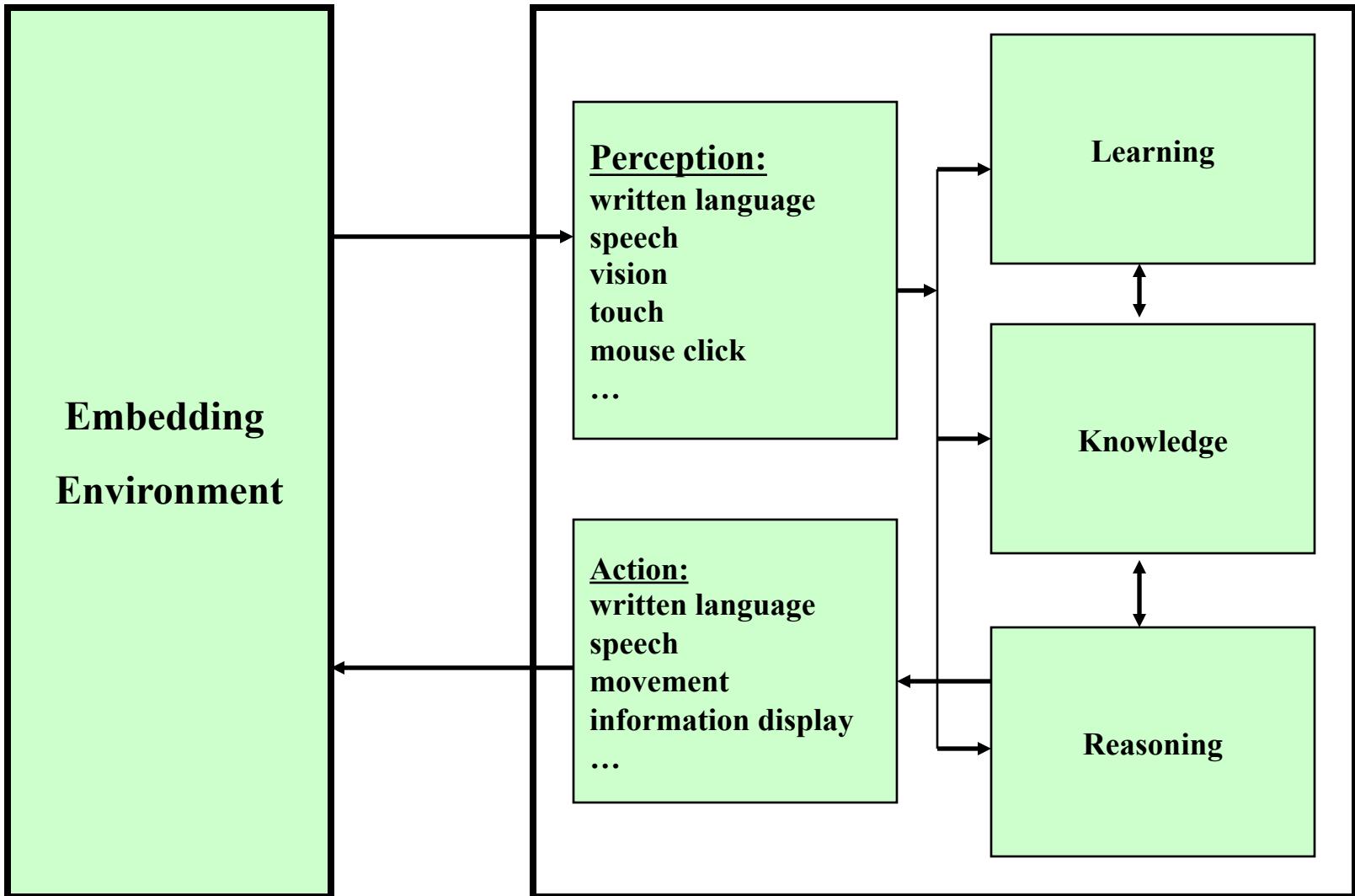
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### AI vs 8th Grade: The Allen AI Science Challenge

To put this approach to the test, AI2 designed and hosted "The Allen AI Science Challenge," a four month long competition in partnership with Kaggle.com that concluded in February of 2016. Researchers worldwide were invited to build AI software that could answer standard 8th grade multiple choice science questions. The competition aimed to assess the state of the art in AI systems utilizing natural language understanding and knowledge-based reasoning--how accurately the participants' models could answer the exam questions would serve as an indicator of how far the field has come in these areas. According to AI2's Oren Etzioni, "The Allen AI Science Challenge is an important step towards a rational, quantitative assessment of AI's capabilities, and how these progress over time."

# The Intelligent Agent Architecture



# **Knowledge Representation**

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## ◆ How do we represent knowledge?

- Factual knowledge (facts)
- Uncertain knowledge (beliefs)

## ◆ What knowledge is relevant?

## ◆ How do we acquire knowledge?

- From experts
- By conversion from other forms of knowledge
- By learning from experience

# KR: How do we represent knowledge?

## ◆ Facts

### Knowledge:

There are four people: Roberta, Thelma, Steve, and Pete.

Among them, they hold eight different jobs.

Each holds exactly two jobs.

The jobs are chef, guard, nurse, clerk, police officer (gender not implied), teacher, actor, and boxer.

The job of nurse is held by a male.

The husband of the chef is the clerk.

Roberta is not a boxer.

Pete has no education past the ninth grade.

Roberta, the chef, and the police officer went golfing together.

**Question:** Who holds which jobs?

### Representations:

- Propositional logic
- First order logic
- ...

## First order logic

If HUSBAND(x,jobholder(chef)) then HASAJOB(x,clerk)

FEMALE(jobholder(chef))

If HUSBAND(x,y), then MALE(x) and FEMALE(Y)

If HASAJOB(x,nurse) then  
GREATERTHAN(education(x),9)

...

...

# KR: How do we represent knowledge?

## ◆ Beliefs

### Knowledge:

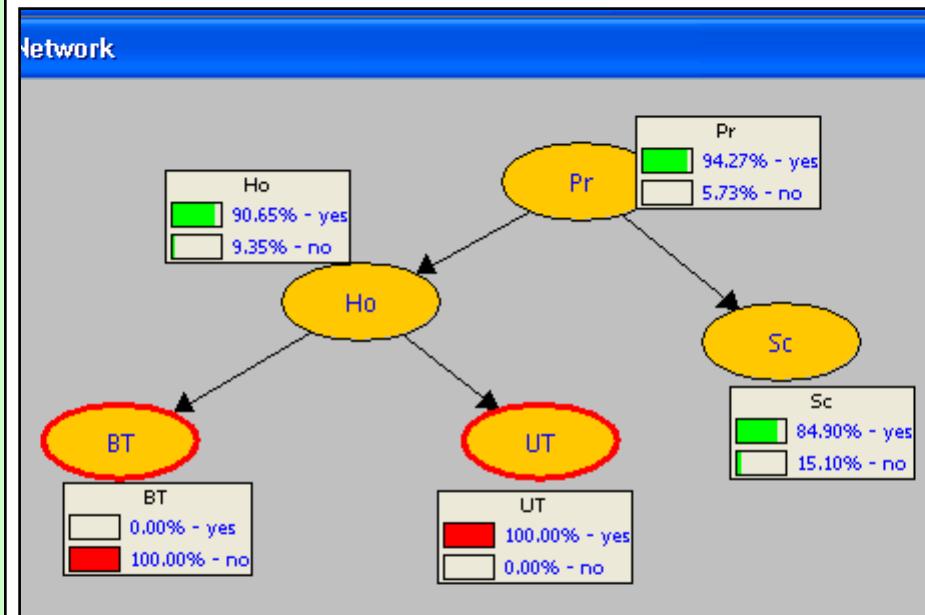
A few weeks after inseminating a cow, we have three possible tests to confirm pregnancy. The first is a scanning test which has a false positive of 1% and a false negative of 10%. The second is a blood test, which detects progesterone with a false positive of 10% and a false negative of 30%. The third test is a urine test, which also detects progesterone with a false positive of 10% and a false negative of 20%. The probability of a detectable progesterone level is 90% given pregnancy, and 1% given no pregnancy. The probability that insemination will impregnate a cow is 87%.

Question: What's the belief in pregnancy given a positive urine test but a negative blood test?

### Representations:

- Belief networks
- Fuzzy logic
- ...

## Belief Networks



# Reasoning

## ◆ How can we formalize the reasoning process?

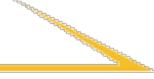
- Deduction: What is implied by a knowledge base?
- Belief revision: What beliefs to give up in case of a contradiction?
- Causality: What is the cause of an event?

## ◆ How can we reason efficiently?

- Time
- Space
- Footprint



# **Reasoning: Formalizing Belief Revision**



Oscar used to believe that he had given Victoria a gold ring at their wedding. He had bought their two wedding rings at a jeweler's shop in Casablanca. He thought it was a bargain. The merchant had claimed that the rings were made of 24 carat gold. They certainly looked like gold, but to be on the safe side Oscar had taken the rings to the jeweler next door who has testified to their gold content.

However, some time after the wedding, Oscar was repairing his boat and he noticed that the sulfuric acid he was using stained his ring. He remembered from his school chemistry that the only acid that affected gold was aqua regia. Somewhat surprised, he verified that Victoria's ring was also stained by the acid.

So Oscar had to revise his beliefs because they entailed an inconsistency. He could not deny that the rings were stained. He toyed with the idea that, by accident, he had bought aqua regia rather than sulfuric acid, but he soon gave up this idea. So, because he had greater confidence in what he was taught in chemistry than in his own smartness, Oscar somewhat downheartedly accepted that the rings were not made of gold after all. Consequently, he was convinced that both jewelers had been lying. He also came to believe that they were in collusion with each other, although he was not completely certain of this.

# **Reasoning: Formalizing Causality**



## ◆ When do we say A caused B?

Needed for explanation

Allow us to predict the future

Suggest ways to control future events

Moral responsibility

Legal liability

## ◆ It is not simply sufficiency, nor necessity...

Billy and Suzy both throw rocks at a bottle. Suzy's arm is better than Billy's, so her rock gets to the bottle first and shatters it. Billy's throw was perfectly accurate, so his rock would have shattered the bottle had Suzy's missed. Did Billy's throw cause the bottle to shatter? What if both rocks hit the bottle simultaneously.

JUDEA PEARL  
*WINNER OF THE TURING AWARD*  
AND DANA MACKENZIE

THE  
BOOK OF  
WHY



THE NEW SCIENCE  
OF CAUSE AND EFFECT

# *Applications of KR&R*

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- ◆ **Medical diagnosis**
- ◆ **Credit card fraud**
- ◆ **Theorem proving (Mathematics)**
- ◆ **Formal verification**
- ◆ **Cognitive tasks: planning, explanation, etc**
- ◆ **Product configuration**

# Applications of KR&R

SCIENCE + TECHNOLOGY

## Artificial intelligence framework developed by UCLA professor now powers Toyota websites

Adnan Darwiche's invention helps consumers customize their vehicles online

Matthew Chin | May 12, 2016



iStock.com/Asian Alphan

A platform developed by UCLA professor Adnan Darwiche helps Toyota and Lexus shoppers see, in real time, which vehicles match their desired criteria.

An innovation in artificial intelligence that was described in a 2001 paper by a UCLA computer science professor has found a somewhat unexpected application: helping

### More Science + Technology



Teams of Bruins create apps to solve problems using latest technologies



Astronomers capture best view ever of disintegrating comet



UCLA chemists report new insights about properties of matter at the nanoscale

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#### UCLA IN THE COMMUNITY

# Applications of KR&R

SCIENCE + TECHNOLOGY

## Artificial intelligence framework developed by UCLA professor now powers Toyota websites

Adnan Darwiche's invention helps consumers customize their vehicles online

Matthew Chin | May 12, 2016

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More Science + Technology



Teams of Bruins create apps to solve problems using latest technologies

Another challenge of sites like Toyota's is that the artificial intelligence decision-making must take place on the user's computer. Having all of those computations take place on the company's servers would overload the system if too many people were using it at the same time, but forcing it to happen on users' machines would allow any number of cars to be configured simultaneously. This, in turn, means that the configurator must use minimal computer memory so it doesn't strain users' home devices.

To accomplish that, knowledge about Toyota's manufacturing combinations and available inventory is compiled into a DNNF circuit, which is then loaded into the shopper's web browser. Configuration takes place within the web browser using simple and efficient DNNF algorithms.

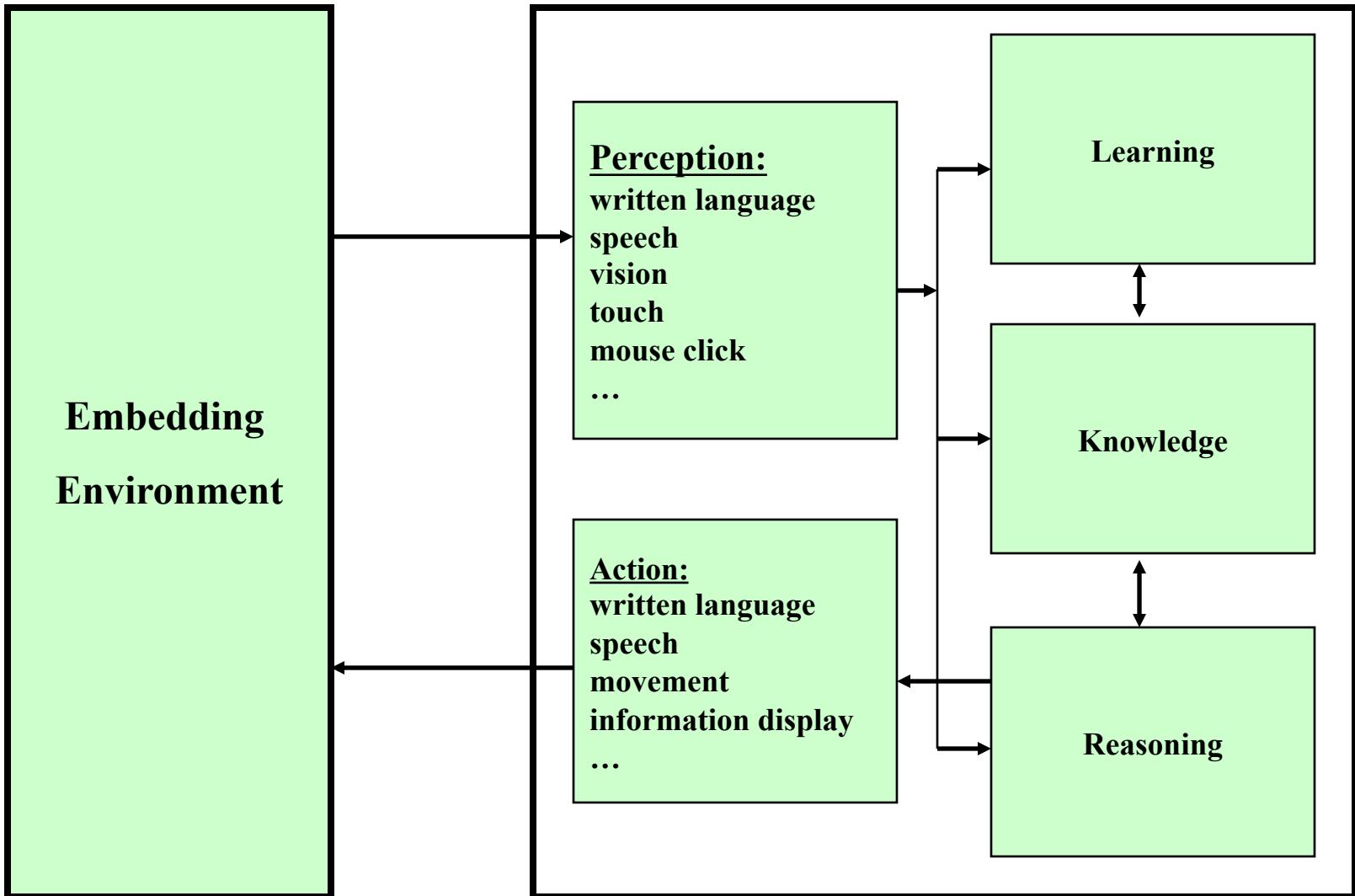


computer science professor has found a somewhat unexpected application: helping

UCLA IN THE COMMUNITY

SCIENCE DEPARTMENT

# The Intelligent Agent Architecture



# **Natural Language Understanding**



## ◆ Understand natural language:

- List all employees that have been working here for more than two years and have not gotten a raise since then.

## ◆ Generate natural language:

- There are actually only two such employees, do you just need their names?

## ◆ Text summarization:

- Here's a 100 word abstract of the article...

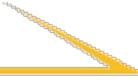
## ◆ Machine translation

- Convert text from one language into another.

## ◆ Speech Transcription (IOS 10), Siri

# **Natural Language Understanding**

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## ◆ Why is it hard? Context and ambiguity.

- Syntactic ambiguity: “They are cooking apples”
- Semantic ambiguity: “She ran to the bank”
- Pragmatic ambiguity: “Can you open the door?”

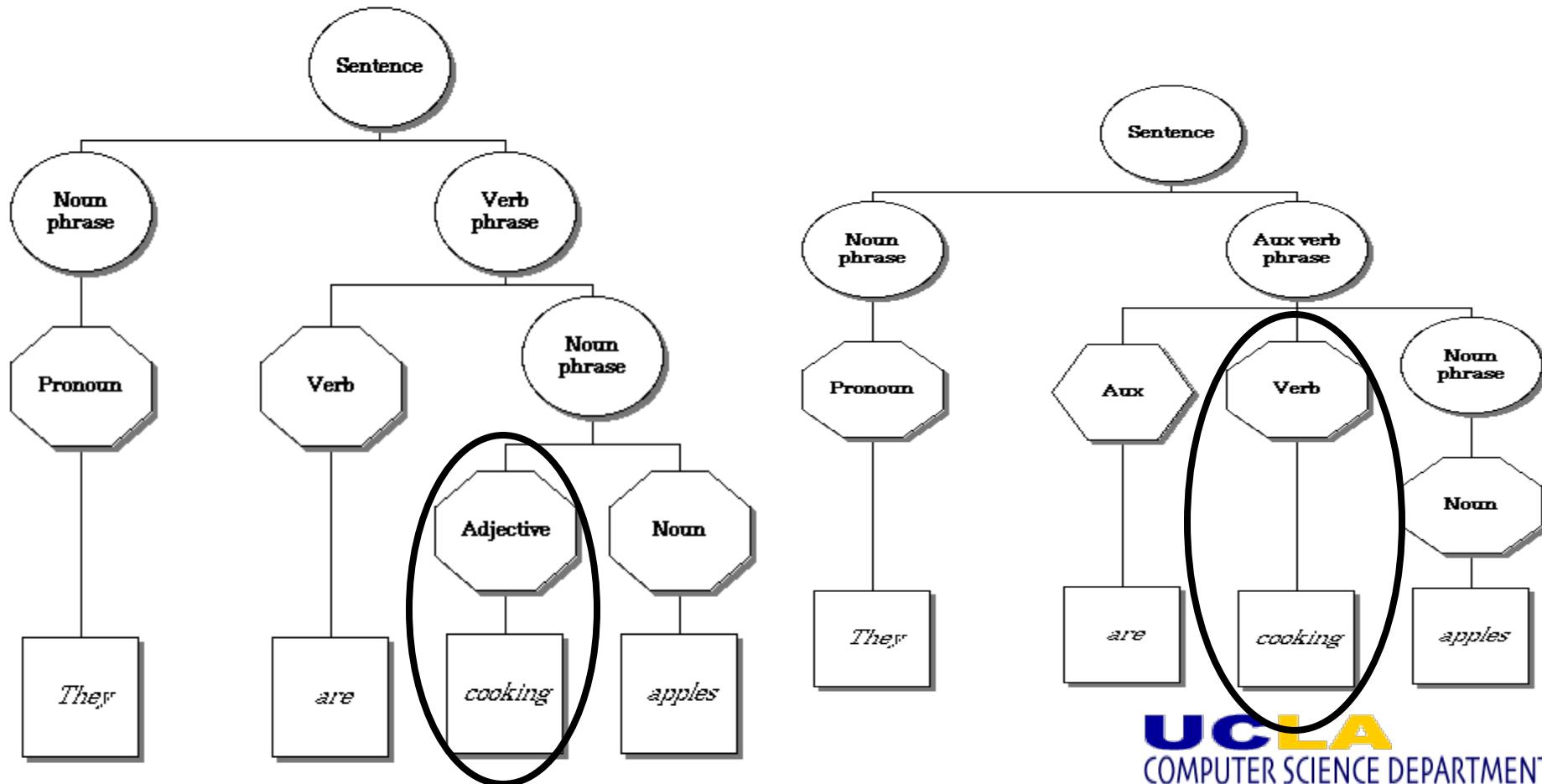
## ◆ Two key approaches:

- Classical: Provide the system with rich knowledge of the world, perform thorough syntactic, semantic and pragmatic analysis, disambiguate using knowledge and reasoning.
- Modern: Rely on corpus and disambiguate using machine learning (applicability in specific contexts).

# Ambiguity and Context

They are cooking apples

sentence → noun phrase , verb phrase  
noun phrase → noun  
noun phrase → determiner , noun  
verb phrase → verb , noun phrase



# Natural Language Understanding: Web Translation

Help

**Google Translate™ BETA**

[Text and Web](#)   [Translated Search](#)   [Dictionary](#)   [Tools](#)

**Translate Text**

Original text:

This is to demonstrate how one can translate from English to Arabic. The system can handle more than thirty languages.

Translation: English » Arabic

هذا هو إظهار كيف يمكن لأحد أن يترجم من اللغة الانكليزية إلى العربية. ويمكن للنظام التعامل مع أكثر من ثلاثين لغة.

English ▾ » Arabic ▾ **Translate**

Arabic  
Bulgarian  
Catalan  
Chinese (Simplified)  
Chinese (Traditional)  
Croatian  
Czech  
Danish  
Dutch  
English  
Filipino

[Suggest a better translation](#)

**Translate a**

http://

Spanish ▾ »

**Gist translation**  
**Bing incident**  
**Spell checker example**

©2008 Google

# Challenges: Robustness

Turkish - detected ▾

English ▾

Bir arastirmaci bu denli mi sagduyulu olabilir ve bu kadar mi guzel ifade edebilir derdini... oluyormus demek ki. Defalarca alinti yapacagim ve zirt pirt gondermede bulunacagim bir makale olmus.

A researcher can be so discreet and so beautiful ... I'll make a note of it many times.

Bir arastirmaci bu denli mi sagduyulu olabilir ve bu kadar mi guzel ifade edebilir derdini... oluyormus demek ki. Defalarca alinti yapacagim ve zirt pirt gondermede bulunacagim bir makale olmus.

194/5000

Is it possible that a research investigator could be so healthy and so beautiful that he could express it... I'm going to make a few more, and I've got an article I'm going to have at the Zirt Pirt.

 **pınar Yolum** @pyolum [Follow](#)

Yapay zekanın neresindeyiz? Yıllar içinde yapay zekayı algılamamız ve ondan beklediğimiz nasıl değişti? Hem akademik, hem toplumsal noktalara değinen çok düşündürücü bir yazı.

 **Human-Level Intelligence or Animal-Like Abilities?**  
What just happened in artificial intelligence and how it is being misunderstood.  
cacm.acm.org

2:21 AM - 3 Oct 2018

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1 11 56

 **Yalçın Tarkan** @yalcintarkan · Oct 3  
Replying to @pyolum @VeriDefteri  
Çok güzel bir yazı, teşekkür ederim 🙏

1 11 56

 **Emre Sevinç** @EmreSevinc · Oct 5  
Bir arastirmaci bu denli mi sagduyulu olabilir ve bu kadar mi guzel ifade edebilir derdini... oluyormus demek ki. Defalarca alinti yapacagim ve zirt pirt gondermede bulunacagim bir makale olmus.

1 2

 **Emre Sevinç** @EmreSevinc · Oct 5  
birilerinin kafasına cooook agır taslar fırlatmış su cümle civarında: "While each of these behaviors seems rational locally, their combination can be harmful to scientific inquiry and hence irrational globally."

1 2

# Challenges: Robustness

Turkish - detected▼				English▼		
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Turkish - detected▼				English▼		
Bir arastirmaci bu denli mi sagduyulu olabilir ve bu kadar mi guzel ifade edebilir derdini				A researcher can be so discreet and can express it so well		
Turkish - detected▼				English▼		
Bir arastirmaci bu denli mi sagduyulu olabilir ve bu kadar mi guzel ifade edebilir derdini.				A researcher can be so discreet and so bewildered.		

**pınar Yolum** [@pyolum](#) [Follow](#)

Yapay zekanın neresindeyiz? Yıllar içinde yapay zekayı algılamamız ve ondan beklenimiz nasıl değişti? Hem akademik, hem toplumsal noktalara değinen çok düşündürücü bir yazı.

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# **Natural Language Understanding: Eliza the Chatbot!**

Try it: [http://www-ai.ijs.si/eliza-cgi-bin/eliza\\_script](http://www-ai.ijs.si/eliza-cgi-bin/eliza_script)

**Adnan:** I want to give an introductory lecture on AI.

**Eliza:** Why do you want to give an introductory lecture on AI?

**Adnan:** Our department chair asked me to.

**Eliza:** Can you elaborate on that?

**Adnan:** He says multiple faculty members will contribute to this class.

**Eliza:** Please go on.

**Adnan:** I don't think you understood what I just said.

**Eliza:** Why do you not think I understood what you just said?

**Adnan:** Because you seem to be rambling.

**Eliza:** Oh, i seem to be rambling.

**Adnan:** Absolutely.

**Eliza:** Please go on.

**Adnan:** I give up!

**Eliza:** Can you elaborate on that?

**Adnan:** You just proved my claim.

**Eliza:** Why do you say your claim?

**Adnan:** Because I made it.

**Eliza:** Do any other reasons not come to mind?

**Adnan:** I think the class have gotten the point about you by now.

**Eliza:** Do you wish to think the class have gotten the point about me?

**Adnan:** Yes.

**Eliza:** Are you sure?

....



# facebook

COMPUTERS

Image Source: REUTERS/Dado Ruvic

## Facebook engineers panic, pull plug on AI after bots develop their own language



Mike Wehner  @MikeWehner

July 31st, 2017 at 12:26 PM

 Share

 Tweet

TECH

ARTIFICIAL INTELLIGENCE

# Elon Musk dismisses Mark Zuckerberg's understanding of AI threat as 'limited'

*Someone get Bezos on the line, there's tech billionaire beef on Twitter*

by James Vincent | @jjvincent | Jul 25, 2017, 6:02am EDT

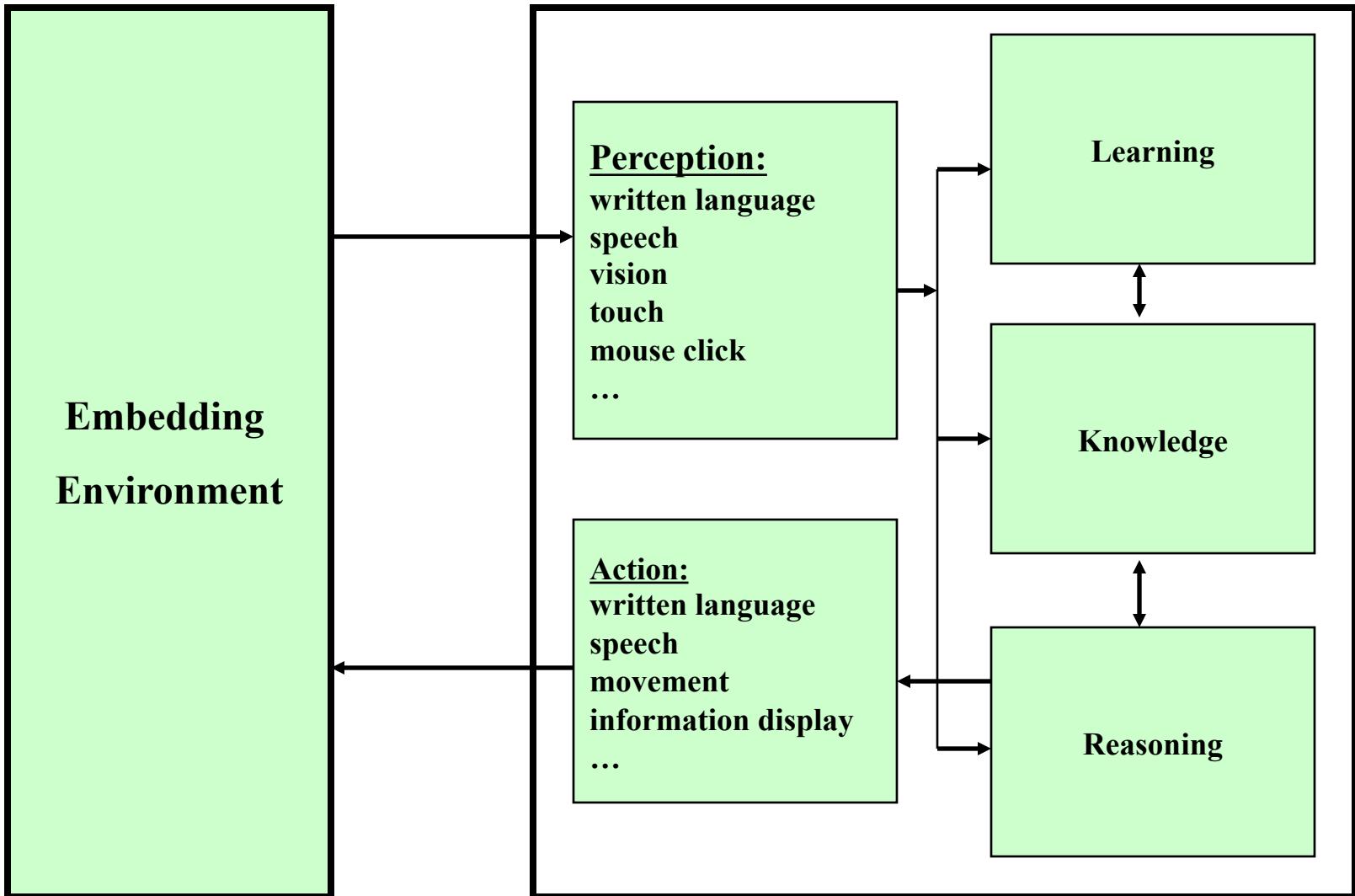
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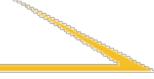
in LINKEDIN



# The Intelligent Agent Architecture



# Machine Learning

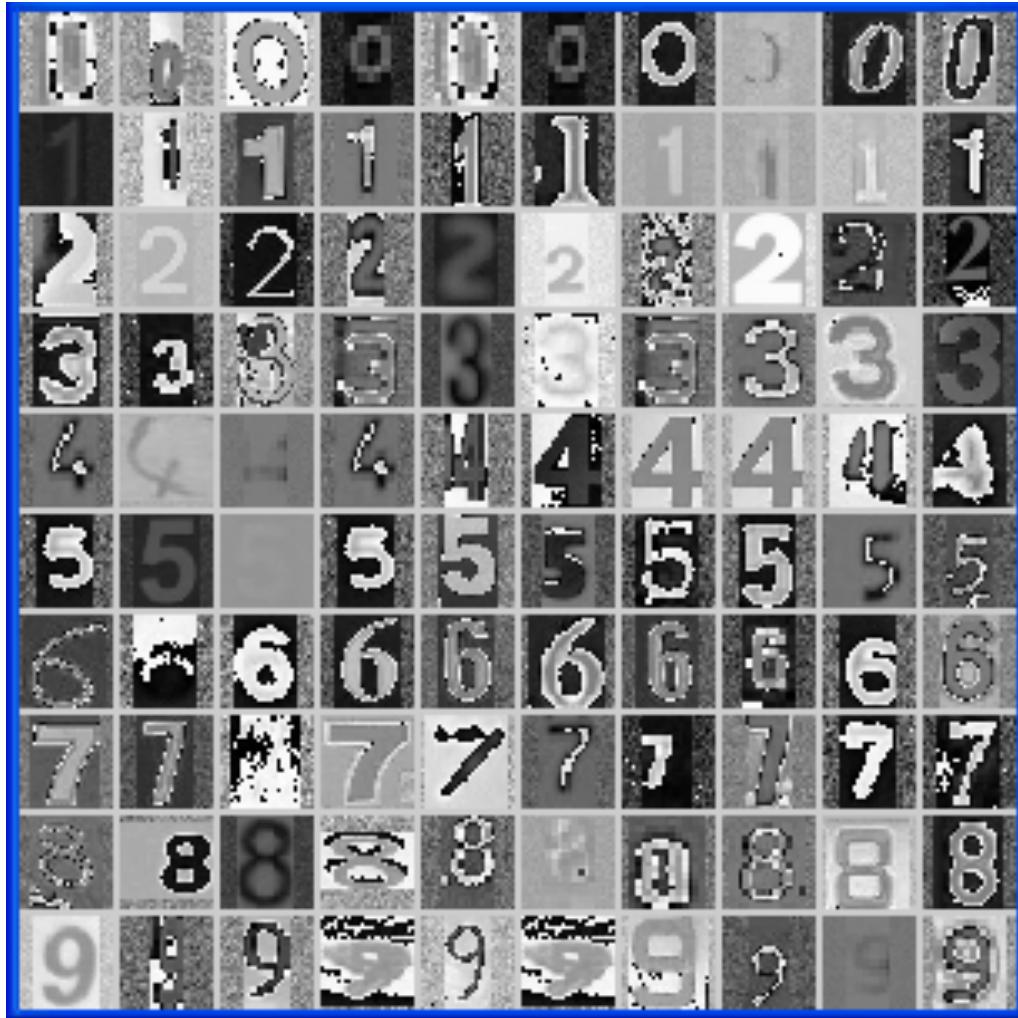


- ◆ Using experiences and observations to improve future performance (actions):

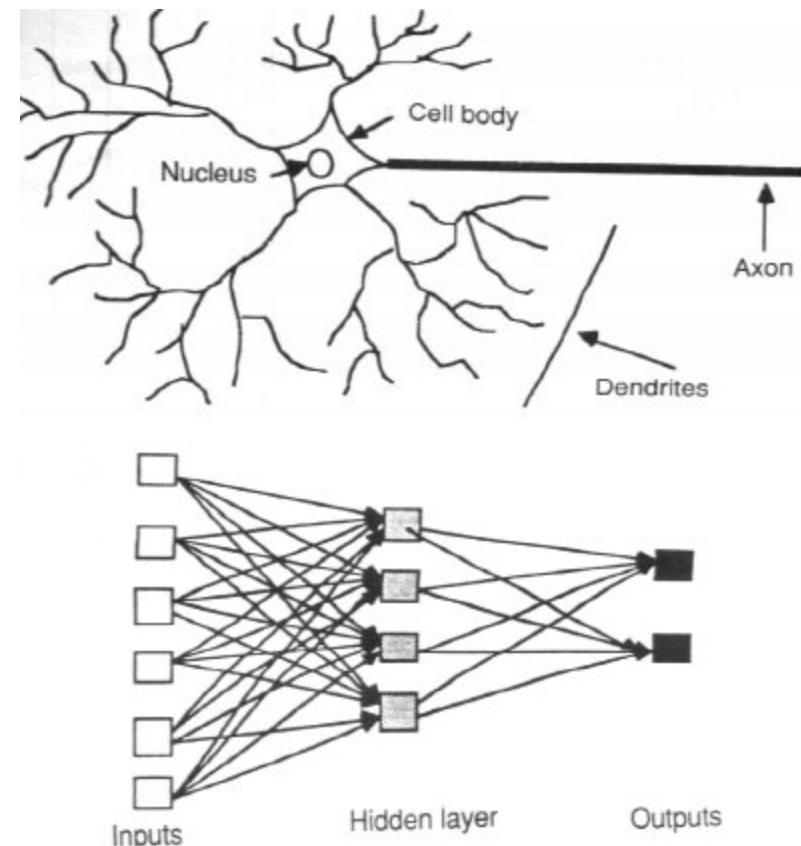
- What aspect of performance to be improved?  
Irrelevant aspects of the world, how the world evolves, what are desirable/undesirable situations.
- What feedback is available?  
Supervised, Unsupervised, Reinforcement learning.
- How to represent the output of a learning process?  
Logical knowledge, Probabilistic knowledge (Bayesian networks), Neural networks,...

- ◆ Supervised: Give observations and actions they should lead to
- ◆ Unsupervised: Give observations only (find patterns)
- ◆ Reinforcement: Give positive/negative feedback on actions

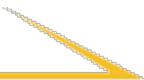
# Supervised Learning: Character Recognition



## Neural Networks



# *Unsupervised Learning: Recommender Systems*



## ◆ E-commerce

- Recommend products based on previous purchases or click-stream behavior
- Ex: Amazon.com

amazon.com.



Featured Item



## ◆ Information sites

- Rate items based on previous user ratings
- Ex: MovieLens, Jester



# Unsupervised Learning: Recommender Systems



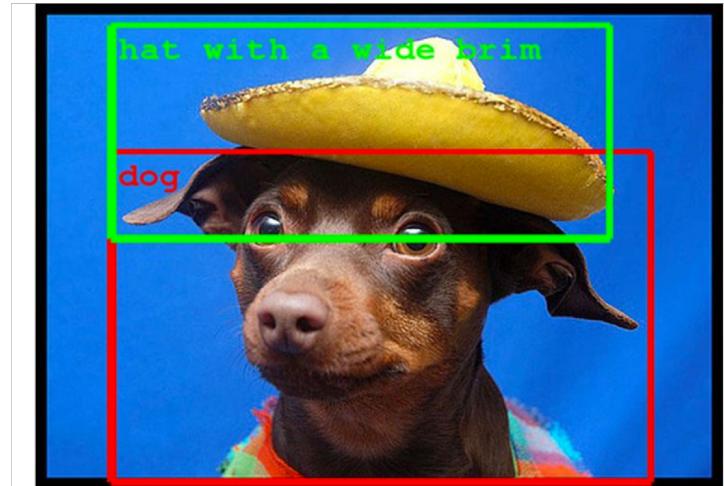
Bob	5	1	3.5	1.7
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Offline Learning

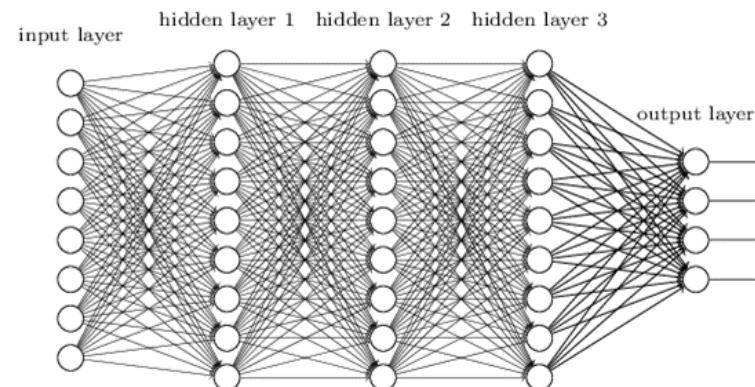
Learned Knowledge

Reasoning

# Deep Learning



Deep neural network



# AI Headlines

**Japanese Scientists Just Used AI to Read Minds and It's Amazing**

**CNBC**

*Catherine Clifford*

*January 8, 2018*

**A New AI That Detects 'Deception' May Bring an End to Lying as We**

**Know It**

**Futurism**

*Dom Galeon*

*January 9, 2018*

**New AI Can Tell If a Person Is Male or Female by Reading Their**

**Smile**

**The Daily Mail**

*Maggie O'Neill*

*March 14, 2018*

**Scientists Learned to Predict Public Corruption With Neural Networks**

**Higher School of Economics (Russia)**

*December 21, 2017*

**Researchers Teach Computer to Recognize Emotions in Speech**

**National Research University Higher School of Economics**

*Liudmila Mezentseva*

*November 8, 2017*

**This New AI Can Track 200 Eye Movements to Determine Your Personality Traits**

**Business Insider**

*Katharina Mass*

*September 2, 2018*

# Planning

- ◆ **Finding a sequence of actions that will achieve a goal**

## Input:

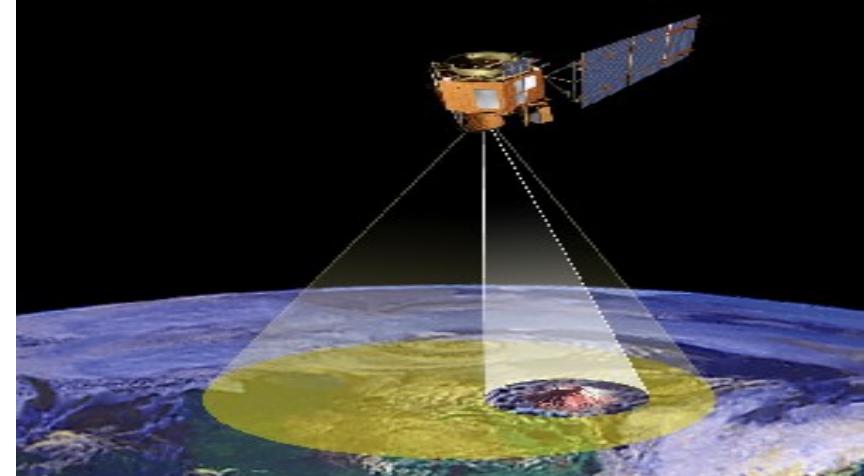
- Actions (preconditions, effects)
- Initial, Goal states
- Knowledge of world (physics)

## Output: Plan:

- Conditional (contingency)
- Total/Partial
- Sensorless (conformant)

## *Autonomous Sciencecraft Experiment:*

uses on-board science analysis and re-planning to radically increase science return by enabling intelligent downlink selection and autonomous retargeting.

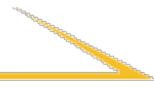


## *Multi-Rover Integrated Science Understanding System:*

develops architectures and technologies for command and control of multi-rover groups for planetary exploration.



# **NASA: Autonomous Sciencecraft Experiment**



- ◆ Use onboard decision-making to detect, analyze, and respond to science events, and to downlink only the highest value science data.
- ◆ Radically increase science return by enabling intelligent downlink selection and autonomous retargeting.
- ◆ AI Technology Used:
  - Image analysis
  - Planning, scheduling and recovery
- ◆ Mission status updates:

<http://www-aig.jpl.nasa.gov/public/planning>

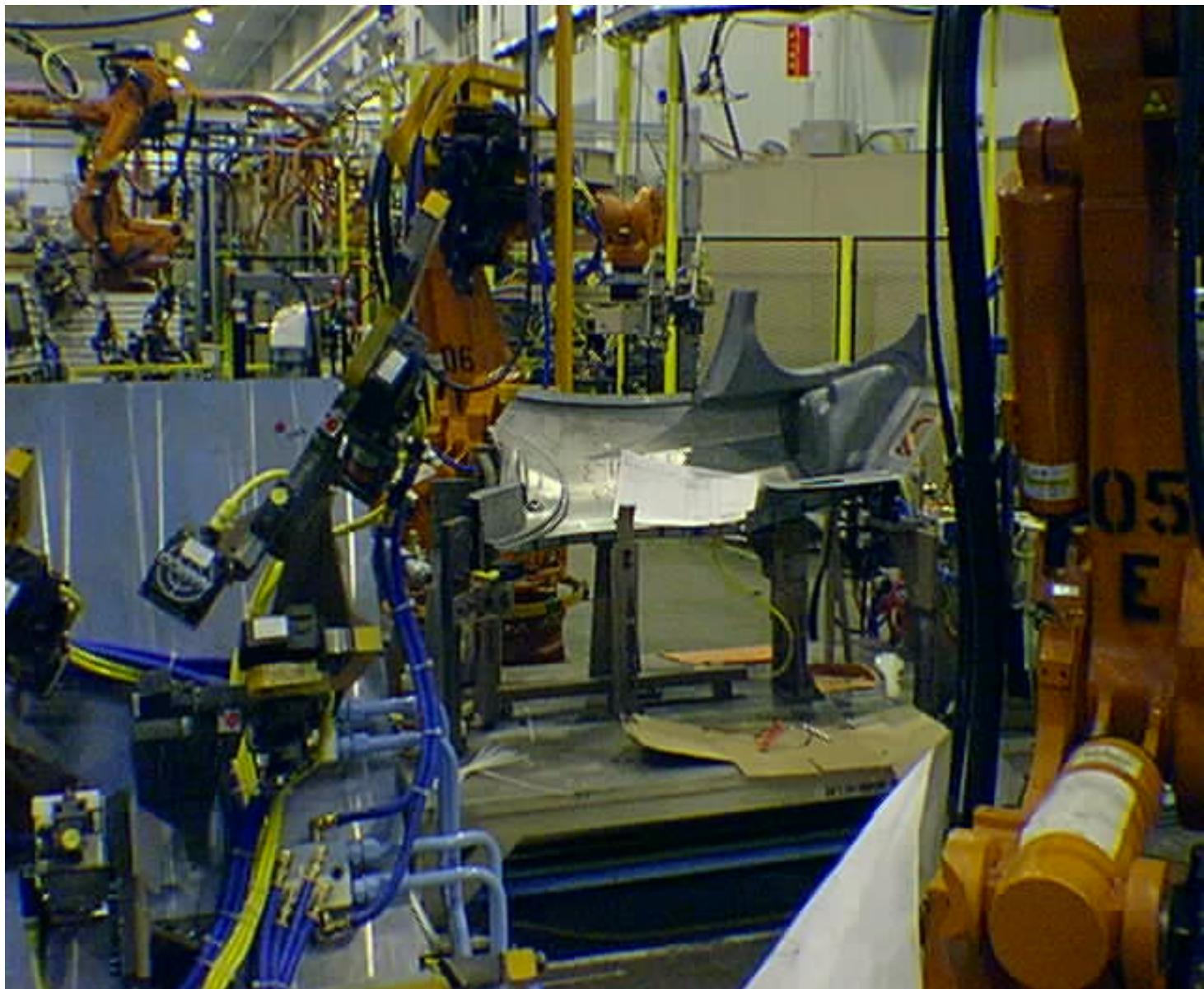
# **Robotics**

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- ◆ **Robots: Physical agents that perform tasks by manipulating the world. Equipped with:**
  - **Effectors: legs, wheels, joints, grippers**
  - **Sensors: cameras, ultrasound, gyroscopes, accelerometers.**
- ◆ **Common categories of robots:**
  - **Manipulators (robot arms): factory assembly lines, international space station.**
  - **Mobile robots: unmanned land/air/water vehicles, planetary rovers**
  - **Mobile robots with manipulators: humanoid (mimic human torso)**

# *Robotics: Manipulators in manufacturing*

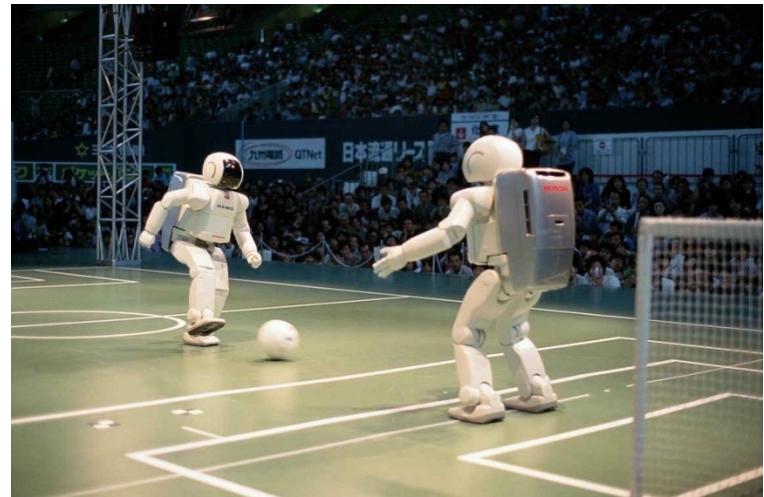


# Robotics: Humanoids



Integrating:

- Voice recognition and synthesis
- Vision
- Knowledge representation and reasoning
- ...



## People also ask

### What is Asimo?

**ASIMO**, an acronym for Advanced Step in Innovative MObility, is a humanoid robot designed and developed by Honda. Introduced on 21 October 2000, **ASIMO** was designed to be a multi-functional mobile assistant.

[ASIMO - Wikipedia, the free encyclopedia](#)

[en.wikipedia.org/wiki/ASIMO](https://en.wikipedia.org/wiki/ASIMO)

Search for: [What is Asimo?](#)

### How much is the Asimo robot?

"Two museums in Japan have also leased Asimo units. The intension is to carefully introduce humanity to robots in ways that seem fun and positive. But leasing one is not cheap: **about \$150,000 a month.**"

[Talk:ASIMO - Wikipedia, the free encyclopedia](#)

<https://en.wikipedia.org/wiki/Talk%3AASIMO>

Search for: [How much is the Asimo robot?](#)

### What is Asimo and who made it?

Honda's **ASIMO** robot functions in a real workplace, where **ASIMO's** size is appropriate for many office tasks. **ASIMO's** body is **made** of magnesium alloy covered with a plastic resin, which makes **ASIMO** very durable and lightweight.

[Inside ASIMO Robotics by Honda | The Technology Behind ...](#)

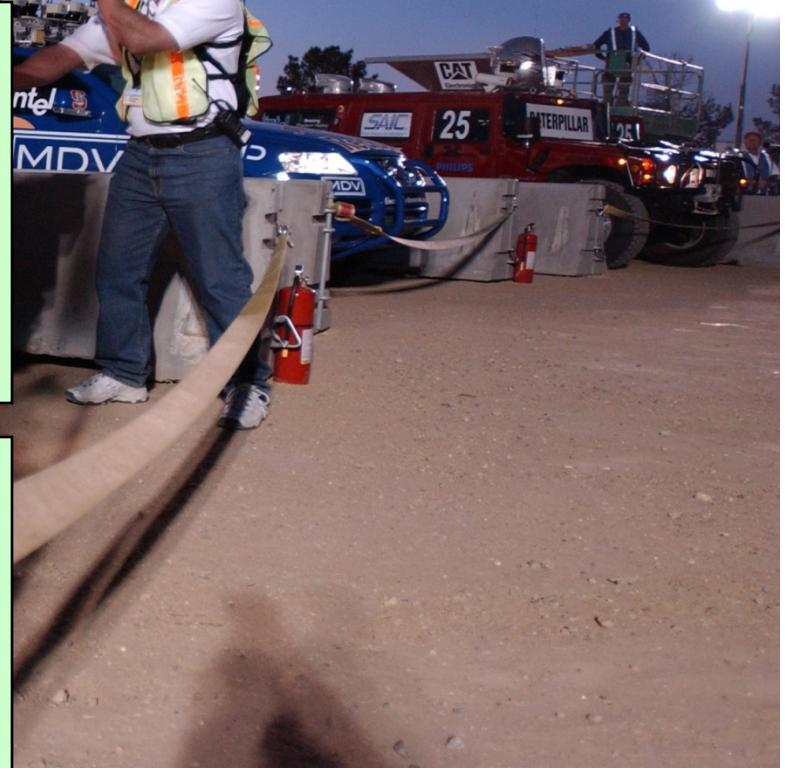
[asimo.honda.com/inside-asimo/](http://asimo.honda.com/inside-asimo/)

# Robotics: DARPA Grand Challenge



## 2004 Challenge:

- 142 miles from Barstow, California to Primm, Nevada
- \$1M prize
- 15 robots qualified, none finished the race
- 7.4 miles was furthest distance



## 2005 Challenge:

- 132 miles in the Mojave desert
- \$2M prize
- 24 robots qualified, 5 finished the race
- Top team: 132 miles in 6 hours, 53 minutes.

# Robotics: DARPA Grand Challenge

The screenshot shows the official website for the DARPA Urban Challenge. At the top left is the DARPA logo with the tagline "BRIDGING THE GAP... POWERED BY IDEAS". The main header features an aerial view of a city street and the text "URBAN CHALLENGE". Below the header, there's a "Welcome" message and a search bar. On the left side, a vertical menu lists "Home", "Overview", "Teams", "Schedule", "Rules", "Media", and "Gallery". The central content area contains a paragraph about the event's history and goals, followed by a photograph of several autonomous vehicles lined up under flags. To the right of the photo is a summary of the team selection process.

**Welcome**      Search

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The DARPA Urban Challenge was held on November 3, 2007, at the former George AFB in Victorville, Calif. Building on the success of the [2004](#) and [2005](#) Grand Challenges, this event required teams to build an autonomous vehicle capable of driving in traffic, performing complex maneuvers such as merging, passing, parking and negotiating intersections. This event was truly groundbreaking as the first time autonomous vehicles have interacted with both manned and unmanned vehicle traffic in an urban environment.



[Teams](#) from around the world were whittled down through a series of qualifying steps, beginning with technical papers and videos, then advancing to actual vehicle testing at team sites. Of the 89 teams to initially apply, 35 teams were invited to the [National Qualification Event](#) (NQE), a rigorous eight-day vehicle testing period. The NQE was co-located with the Final Event in Victorville, CA. DARPA transformed the roads of the former George AFB into an autonomous vehicle testing ground, laying over four miles of protective k-rail barriers in creating multiple test courses.

## 2007 Challenge (<http://www.darpa.mil/grandchallenge>):

- Former George AFB in Victorville, Calif
- Driving in traffic, performing complex maneuvers: merging, passing, parking and negotiating intersections
- 1st time autonomous vehicles interacted with both manned and unmanned vehicle traffic in an urban environment

# History and Background

*See also: Driverless car#History*

Fully autonomous vehicles have been an international pursuit for many years, from endeavors in Japan (starting in 1977), Germany (Ernst Dickmanns and VaMP), Italy (the ARGO Project), the European Union (EUREKA Prometheus Project), the United States of America, and other countries.

The Grand Challenge was the first long distance competition for driverless cars in the world; other research efforts in the field of [Driverless cars](#) take a more traditional commercial or academic approach. The U.S. Congress authorized DARPA to offer prize money (\$1 million) for the first Grand Challenge to facilitate robotic development, with the ultimate goal of making one-third of ground military forces autonomous by 2015. Following the 2004 event, Dr. Tony Tether, the director of DARPA, announced that the prize money had been increased to \$2 million for the next event, which was claimed on [October 9, 2005](#). The first, second and third places in the 2007 Urban Challenge received \$2 million, \$1 million, and \$500,000, respectively.

The competition was open to teams and organizations from around the world, as long as there were at least one U.S. citizen on the roster. Teams have participated from high schools, universities, businesses and other organizations. More than 100 teams registered in the first year, bringing a wide variety of technological skills to the race. In the second year, 195 teams from 36 [US states](#) and 4 foreign countries entered the race.

## 2004 Grand Challenge

[edit]

*Main article: DARPA Grand Challenge (2004)*

The first competition of the DARPA Grand Challenge was held on March 13, 2004 in the [Mojave Desert](#) region of the [United States](#), along a 150-mile (240 km) route that follows along the path of [Interstate 15](#) from just before [Barstow, California](#) to just past the [California-Nevada](#) border in [Primm](#). None of the robot vehicles finished the route. [Carnegie Mellon University](#)'s Red Team traveled the farthest distance, completing 11.78 km (7.36 miles) of the course.

## 2005 Grand Challenge

[edit]

*Main article: DARPA Grand Challenge (2005)*

The second competition of the DARPA Grand Challenge began at 6:40am on [October 8, 2005](#). All but one of the 23 finalists in the 2005 race surpassed the 11.78 km (7.36 mile) distance completed by the best vehicle in the 2004 race. Five vehicles successfully completed the race:

Vehicle	Team Name	Team Home	Time Taken (h:m)	Result
Stanley	Stanford Racing Team	Stanford University, Palo Alto, California	6:54	First place
Sandstorm	Red Team	Carnegie Mellon University, Pittsburgh, Pennsylvania	7:05	Second place
H1ghlander	Red Team Too		7:14	Third place
Kat-5	Team Gray	The Gray Insurance Company, Metairie, Louisiana	7:30	Fourth place
TerraMax	Team TerraMax	Oshkosh Truck Corporation, Oshkosh, Wisconsin	12:51	Over 10 hour limit, fifth place



Stanley, the winner of the 2005 DARPA Grand Challenge

Vehicles in the 2005 race passed through three narrow tunnels and negotiated more than 100 sharp left and right turns. The race concluded through Beer Bottle Pass, a winding mountain pass with sheer drop-offs on both sides. Although the 2004 course required more elevation gain and some very sharp switchbacks (Daggett Ridge) were required near the beginning of the route, the course had far fewer curves and generally wider roads than the 2004 course.

The natural rivalry between the teams from [Stanford](#) and [Carnegie Mellon](#) ([Sebastian Thrun](#), head of the Stanford team was previously a faculty member at Carnegie Mellon and colleague of [Red Whittaker](#), head of the CMU team) was played out during the race. Mechanical problems plagued H1ghlander before it was passed by Stanley. Gray Team's entry was a miracle in itself, as the team from the suburbs of New Orleans was caught in [Hurricane Katrina](#) a few short weeks before the race. The fourth finisher, Terramax, a 30,000 pound entry from [Oshkosh Truck](#), finished on the second day. The huge truck spent the night idling on the course, but was particularly nimble in carefully picking its way down the narrow roads of Beer Bottle Pass.



A vehicle that was developed for the 2007 DARPA Urban Challenge

## 2007 Urban Challenge

[edit]

*Main article: DARPA Grand Challenge (2007)*

The third competition of the DARPA Grand Challenge<sup>[2]</sup>, known as the "Urban Challenge", took place on November 3, 2007 at the site of the now-closed [George Air Force Base](#) (currently used as [Southern California Logistics Airport](#)), in [Victorville, California](#) ([Google map](#)).<sup>[1]</sup> The course involved a 96 km (60-mile) urban area course, to be completed in less than 6 hours. Rules included obeying all [traffic](#) regulations while negotiating with other traffic and obstacles and merging into traffic.

The \$2 million winner was [Tartan Racing](#), a collaborative effort by [Carnegie Mellon University](#) and [General Motors Corporation](#), with their vehicle "Roee", a Chevy Tahoe. The second place finisher

## Related: The most dangerous thing about Autopilot is that it's called Autopilot

On May 7, Joshua Brown [was killed](#) when his Model S hit the trailer of a semi-truck that was [crossing the highway in front of him](#). Tesla ([TSLA](#)) confirms that car was in autopilot mode at the time of the accident, and that neither Brown nor autopilot applied the brakes before the crash.

Both the National Highway Traffic Safety Administration and the National Transportation Safety Board are investigating that crash. The NTSB, best known for examining airline crashes and train wrecks, has a team of investigators headed to Florida to look into the crash starting Tuesday, said spokesman Christopher O'Neal. It investigates only about 25 to 30 highway crashes year.

"The interest in this accident relates to the use of automation," he said. "There's an opportunity to learn from the information about how automation is introduced into American highways."

On Friday July 1, Detroit area art gallery owner Albert Scaglione, 77, flipped his [Model X onto its roof](#) while driving on the Pennsylvania Turnpike about 100 miles east of Pittsburgh. He told CNNMoney that he was in autopilot mode, though he wouldn't comment further on the accident. Both Scaglione and his passenger, his son-in-law, were treated and released at a nearby hospital following the accident.

-- CNNMoney's Matt McFarland contributed to this report

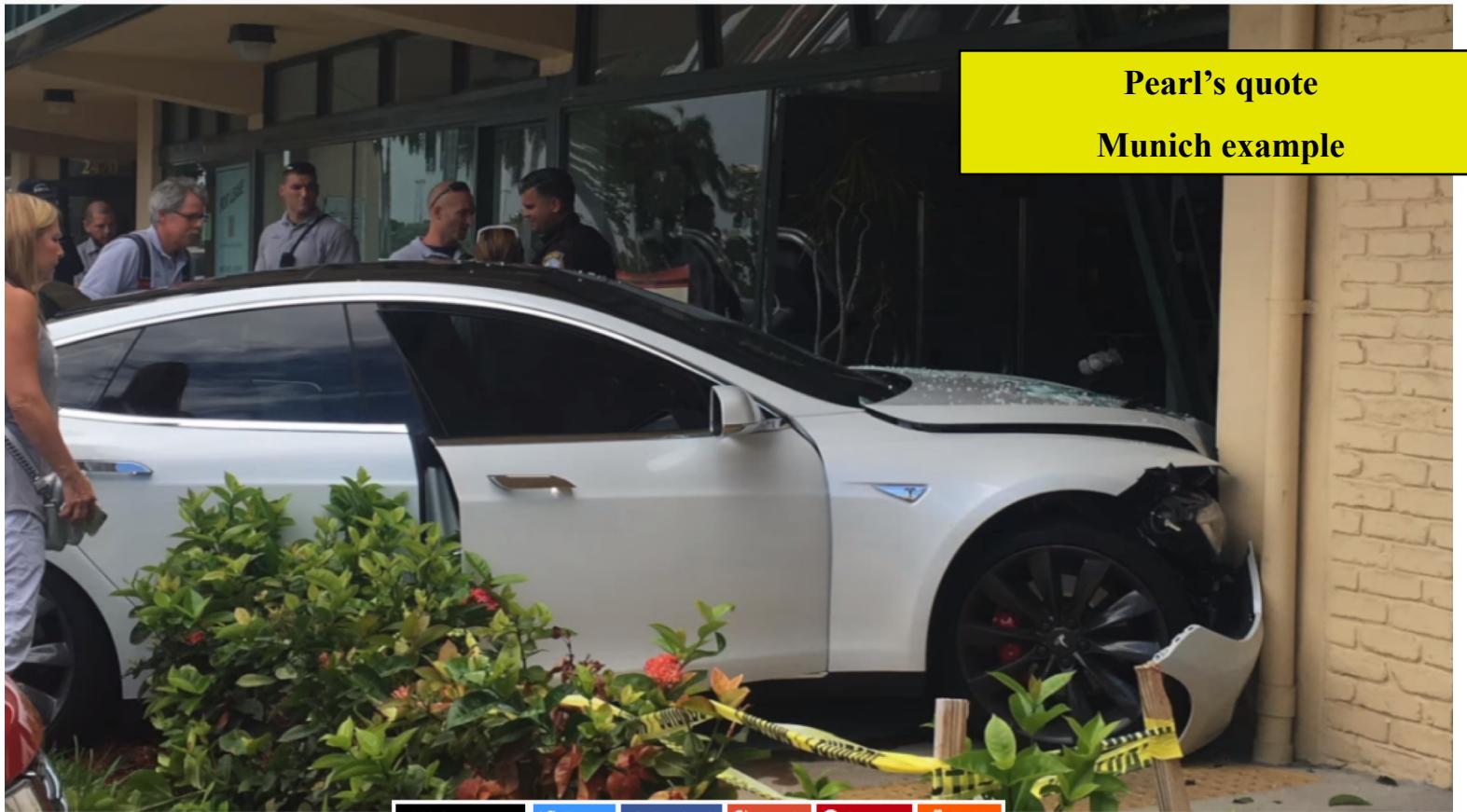
# Tesla Model S crashes into a gym, driver claims autonomous acceleration, Tesla says driver's fault

Fred Lambert - 9 hours ago  @FredericLambert

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Back in June, we reported on a peculiar accident in Irvine, California, where a Tesla Model X suddenly accelerated in a parking lot and ended up crashing into a building. Fortunately, no one was injured during the event. What was particularly interesting about the accident is that the driver claimed the vehicle accelerated on its own. Tesla reviewed the logs and claimed that the accelerator pedal was pressed.

The Switch

# Elon Musk said a Tesla could drive itself across the country by 2018. One just crashed backing out of a garage.

By **Drew Harwell**

September 13

When Mangesh Gururaj's wife left home to pick up their child from math lessons one Sunday earlier this month, she turned on her Tesla Model S and hit "Summon," a self-parking feature that the electric automaker has promoted as a central step toward driverless cars.

But as the family's \$65,000 sedan reversed itself out of the garage, Gururaj said, the car abruptly struck the garage's side wall, ripping its front end off with a loud crack. The maimed Tesla looked as if it would have kept driving, Gururaj said, if his wife hadn't hit the brakes.

No one was hurt, but Gururaj was rattled: The car had failed disastrously, during the simplest of maneuvers, using one of the most basic features from the self-driving technology he and his family had trusted many times at higher speeds.

"This is just a crash in the garage. You can fix this. But what if we were summoning and there was a child it didn't see?" said Gururaj, an IT consultant in North Carolina, who bought the car last year. "I had a lot of trust in Tesla, as a car, but that's gone. ... You're talking about a big liability, and your life is at stake."

The Switch

# Shaken by hype, self-driving leaders adopt new strategy: Shutting up

By **Drew Harwell**

October 18

PALO ALTO, Calif. — Three former executives at Google, Tesla and Uber who once raced to be the first to develop self-driving cars have adopted a new strategy: Slow down. And shut up.

At their new company Aurora Innovation, which is developing self-driving technology for carmakers including Volkswagen and Hyundai, the rules are simple: No flashy launches, mind-blowing timelines or hyper-choreographed performances on closed tracks. “No demo candy,” said Chris Urmson, a co-founder and former head of Google’s self-driving car team.

Aurora’s long-game technique reflects a new phase for the hyped promise of computer-piloted supercars: a more subdued, more pragmatic way of addressing the tough realities of the most complicated robotic system ever built.

In the wake of several high-profile crashes that dented public enthusiasm in autonomous cars, Aurora’s executives are urging their own industry to face a reality check, saying lofty promises risk confusing passengers and dooming the technology before it can truly take off.

# Challenge: Fairness

## Amazon Scraps Secret AI Recruiting Tool That Showed Bias Against Women

**Reuters**

*Jeffrey Dastin*

*October 9, 2018*

Amazon has discontinued an artificial intelligence recruiting tool its machine learning specialists developed to automate the hiring process because they determined it was biased against women. Starting in 2014, a group of Amazon researchers created 500 computer models focused on specific job functions and locations, training each to recognize about 50,000 terms that showed up on past Amazon job candidates' resumes. However, because most resumes submitted to Amazon had come from men, the models tended to favor candidates who described themselves using verbs more commonly found on male engineers' resumes, such as "executed" and "captured." In addition, the program penalized resumes that included the word "women's" and downgraded graduates of two all-women's colleges. Although Amazon declined to comment on the technology's issues, the company said the tool was "never used by Amazon recruiters to evaluate candidates."

**THE WALL STREET JOURNAL**

**AI Can't Reason Why**



...can't tell whether a crowing rooster makes the sun rise, or the other way around.

# Challenge: Explainability



*"Does your car have any idea why my car pulled it over?"*

December 30, 2015

COMPUTER SCIENCE DEPARTMENT

# Challenge: Verification



The Washington Post  
*Democracy Dies in Darkness*

**The Switch**

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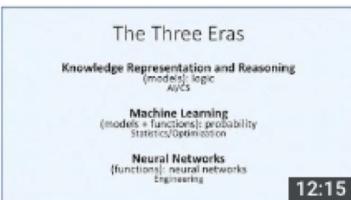


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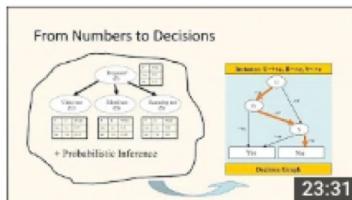
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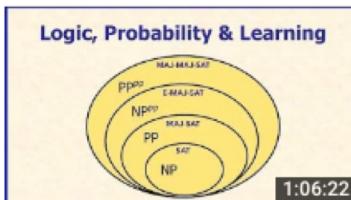
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**Thank you!**

