CSCI 561
Foundations of Artificial Intelligence
Lecture 26: Future of AI

FALL 2018

INSTRUCTOR:

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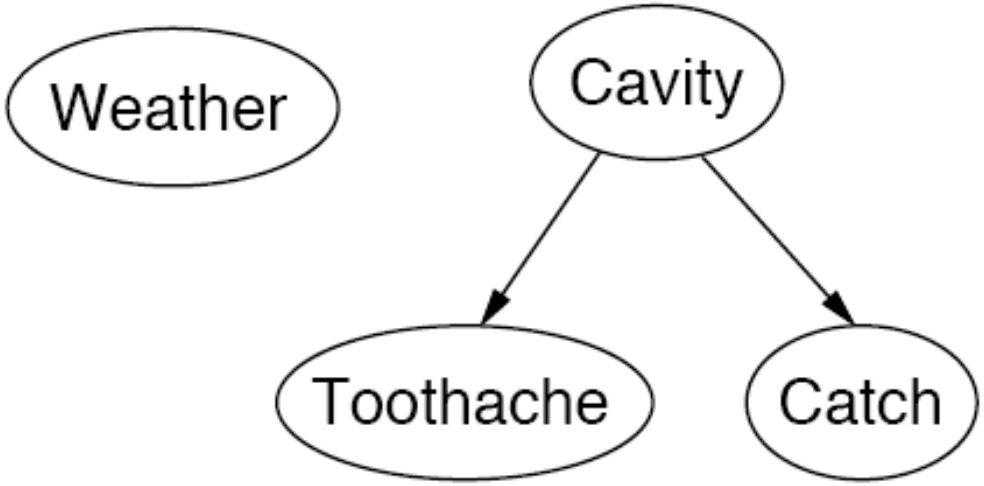
Material covered by Exam 3

- Covers material studied in class after planning. (chap. 13-18, 22, 23)
- Lectures vs Discussion vs book: what to know?
- if a topic is studied in lecture/discussion and is also in the book: need to know both.
- if a topic is studied in lecture/discussion only and is not in the book: know what was studied in class.
- if a topic is in the book but was not covered at all in class: no need to know.
- Opening the exam before you are given the go signal will result in automatic filing of a case with the office of student judicial affairs.
- Cheating during the exam will result in automatic filing of a case with the office of student judicial affairs.
- Continuing to write after the stop signal will result in automatic filing of a case with the office of student judicial affairs.

Independence in Bayesian Networks

Topology of network encodes (conditional) independence assertions:



Weather **is independent of the other variables**

Toothache **and** ***Catch*** **are conditionally independent given** ***Cavity***

Exercise 14.1

We have a bag of three biased coins a, b, and c with probabilities of coming up heads of 20%, 60%, and 80%, respectively. One coin is drawn randomly from the bag (with equal likelihood of drawing each of the three coins), and then the coin is flipped three times to generate the outcomes X_1, X_2, and X_3.

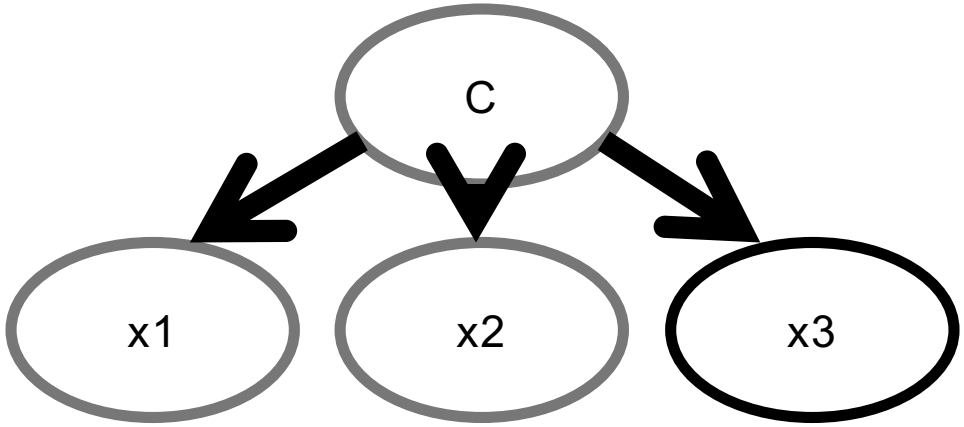
a. Draw the Bayesian network corresponding to this setup and define the necessary CPTs.

b. Calculate which coin was most likely to have been drawn from the bag if the observed flips come out heads twice and tails once.

Exercise 14.1

With the random variable C denoting which coin {a, b, c} we drew, the network has C at the root and X1, X2, and X3 as children.
The CPT for C is:

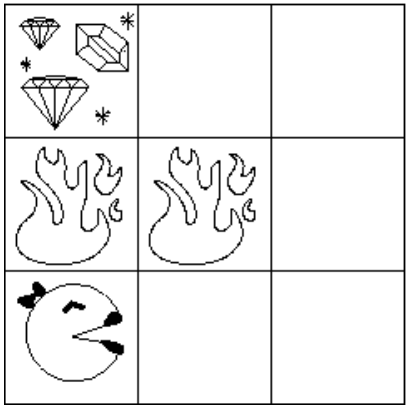
C	$P(C)$
a	$1/3$
b	$1/3$
c	$1/3$



The CPT for X_i given C are the same, and equal to:

C	X_1	P(X|C)
a	$heads$	0.2
b	$heads$	0.6
c	$heads$	0.8

MDP



What are the optimal values and policy?

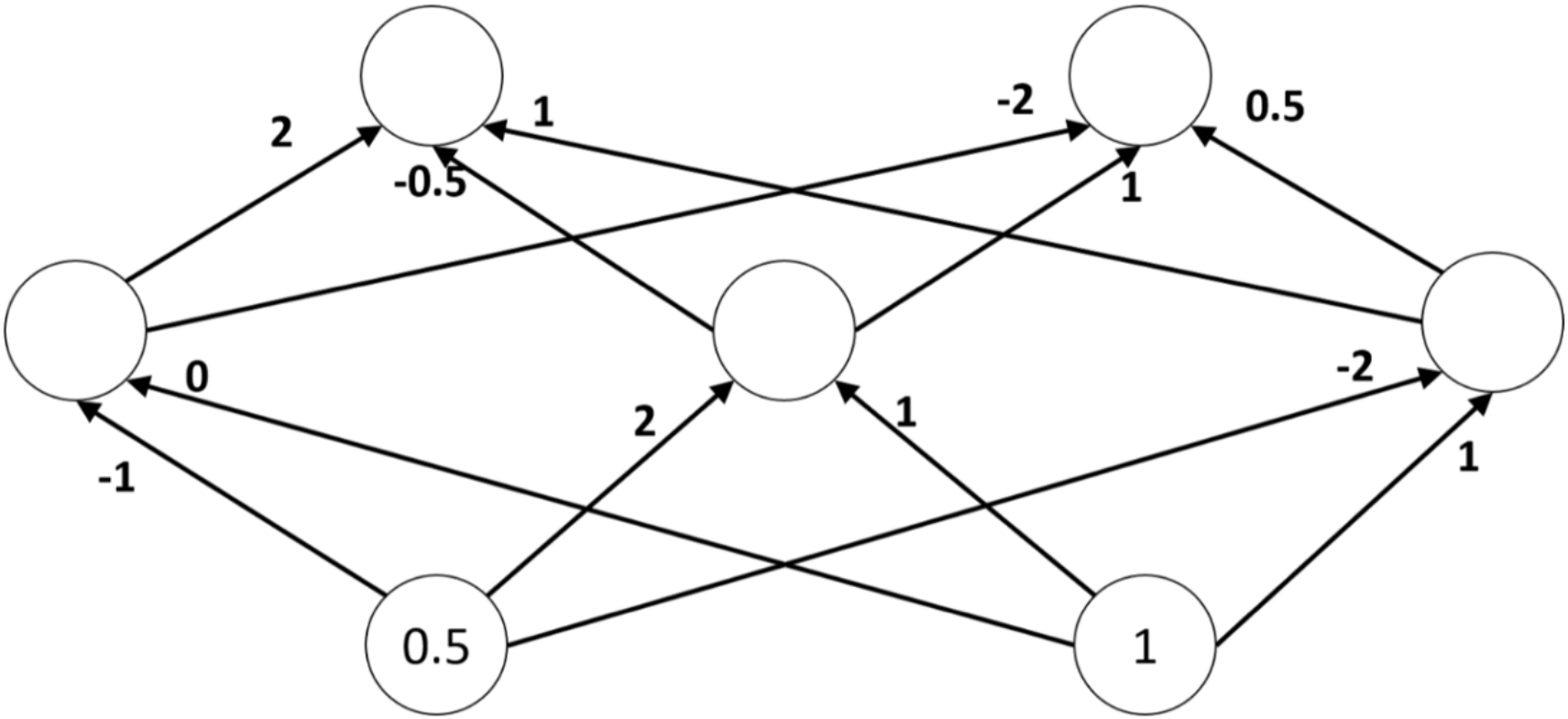
1. What are the optimal values, V^* of each state in the above grid if $\gamma = 0.5$?

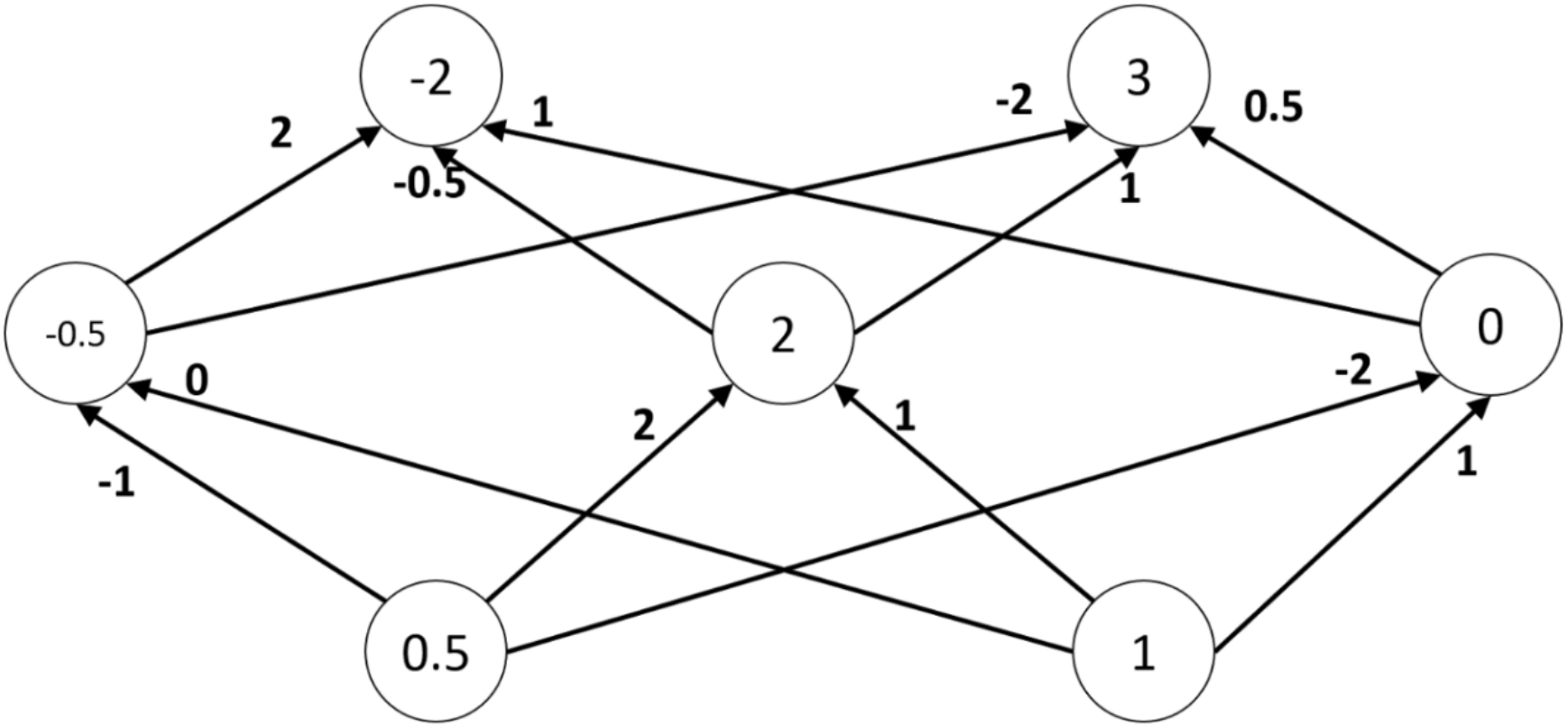
128	64	32
-64	-64	16
2	4	8

Neural Networks

The following is a network of linear neurons, that is, neurons whose output is identical to their net input. The numbers in the circles indicate the output of a neuron, and the numbers at connections indicate the value of the corresponding weight.

7.1. [5%] Compute the output of the hidden-layer and the output-layer neurons for the given input (0.5, 1) and enter those values into the corresponding circles.




-2
3
-0.5
2
0
0.5
1
2
-0.5
1
-2
0.5
1
0
2
-2
1
-1
1

Short Answer

1. List 3 reasons WHY machine learning is needed?

Unknown environments

Adaptability

Lazy

Autonomous

Short Answer

2. What is Ockham's razor? How is it used in neural net learning?

Bias for simplest hypothesis

Prefer fewer hidden units

Reinforcement Learning

1 	2	3	4 
5		6	7 
8	9	10	11

The Past of AI

AI predates computers

- Logic, CSPs, probability theory, grammars: 1000s of years old

Even "new" approaches are already old

- Game-playing machines, *n*-grams: over 100 years old
- Neural networks, the Bellman equation, non-parametric learning, Nash equilibria, HMMs: over 50 years old

The basic concepts of AI have been known for a while

- And now you know them too!

AI Concepts

Dr. Yolanda

Mostly from other fields

- Mathematics (logic, probability theory)
- Philosophy (utility theory, knowledge representation)
- Psychology (cognitive architecture)
- Economics (game theory)
- Linguistics (grammars)
- Operations research (MDPs)
- Biology (neural networks, genetic algorithms)

It helps to study these original fields, too.

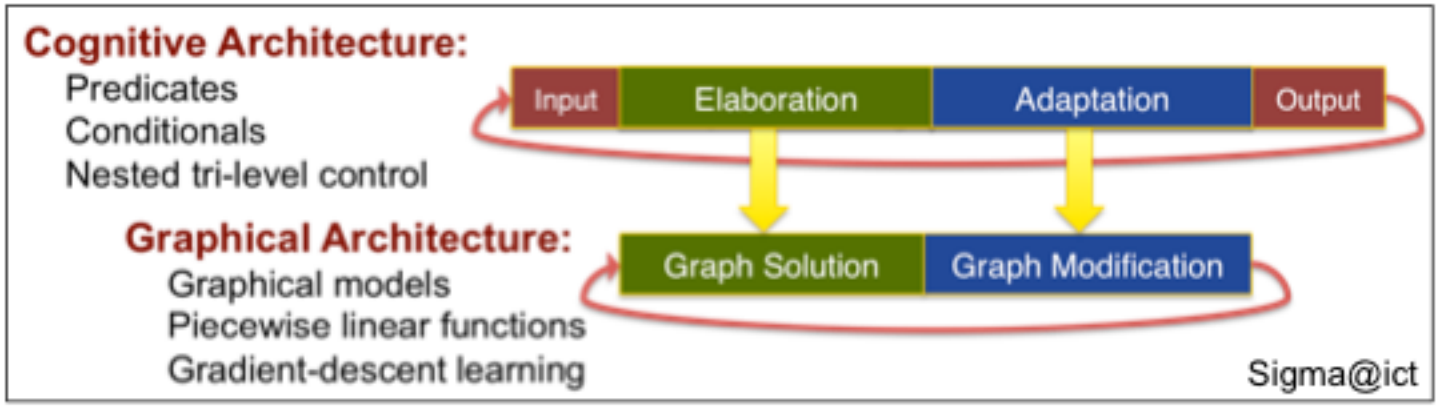
AI is also contributing to scientific discovery in other fields.

Cognitive Architectures

Can we build a general AI system?

- Knowledge representation
- Inference
- Decision making
- Learning

Dr. Paul Rosembloom



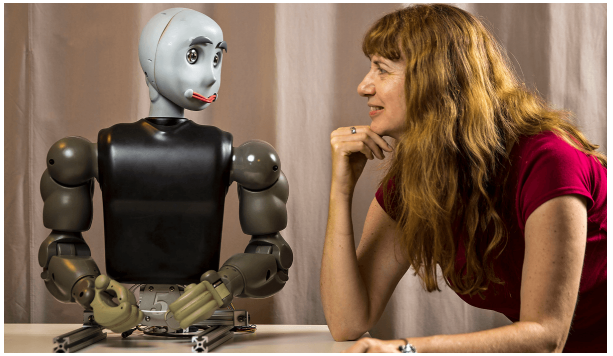
What AI is good at and what it's not

"…by and large, tasks that are hard for humans are easy for computers, and vice versa."

"The simplest computer can run rings around the brightest person when it comes to wading through complicated mathematical equations."

"At the same time, the most powerful computers have, in the past, struggled with things that people find trivial, such as recognizing faces, decoding speech and identifying objects in images."

Robots



Dr. Maja Mataric

AI in a physical form

- **PRO:** The result feels more “satisfying” than, say, a SVM
- **CON:** The physical world is a tough place to work

Social Simulation

Simulate hypotheticals that you can't try out for real

- e.g., responding to an earthquake
- e.g., medical intervention campaign

More data becoming available

- Social science used to rely on small-scale lab experiments
- Now, real-world behavior is available and quantifiable
  - Social media provides a lens to see people's thoughts
  - Video processing is increasingly accessible to scientists

Build agents that represent real people

- Capturing their subjective beliefs, motivations, decisions, etc.
- Run them to see how they respond to hypothetical scenarios

Neuroscience

We know more and more about how the brain works

- fMRI allows us to see brain activity during specific tasks
- Observed activity can inspire deep neural networks
  - Can also inspire more symbolic approaches

Brain-machine interfaces

- ML to interpret EEG signals to control devices
  - **CON:** Even noisier than speech signals
  - **PRO:** Potentially as fast as thought
- Especially valuable for rehabilitation engineering
  - e.g., prosthetics

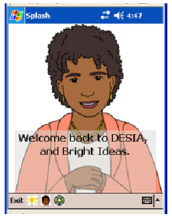
Source: University of Huston

AI in Education

Personalized learning experience

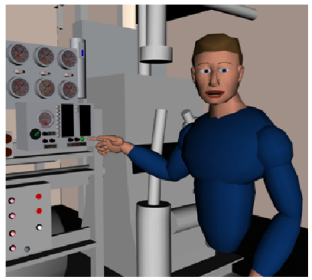
- Knowledge tracing
- Recognition of affective and motivational states
- Adapt to you
- Pedagogical agents

Cosmo



Gina


AutoTutor


Steve


Laura


Herman


Adele

Source: educationaldatamining.org

ITS 2018
Montreal
CANADA
11-15 JUNE

AIED 2018

AI (Machine Learning) in Business

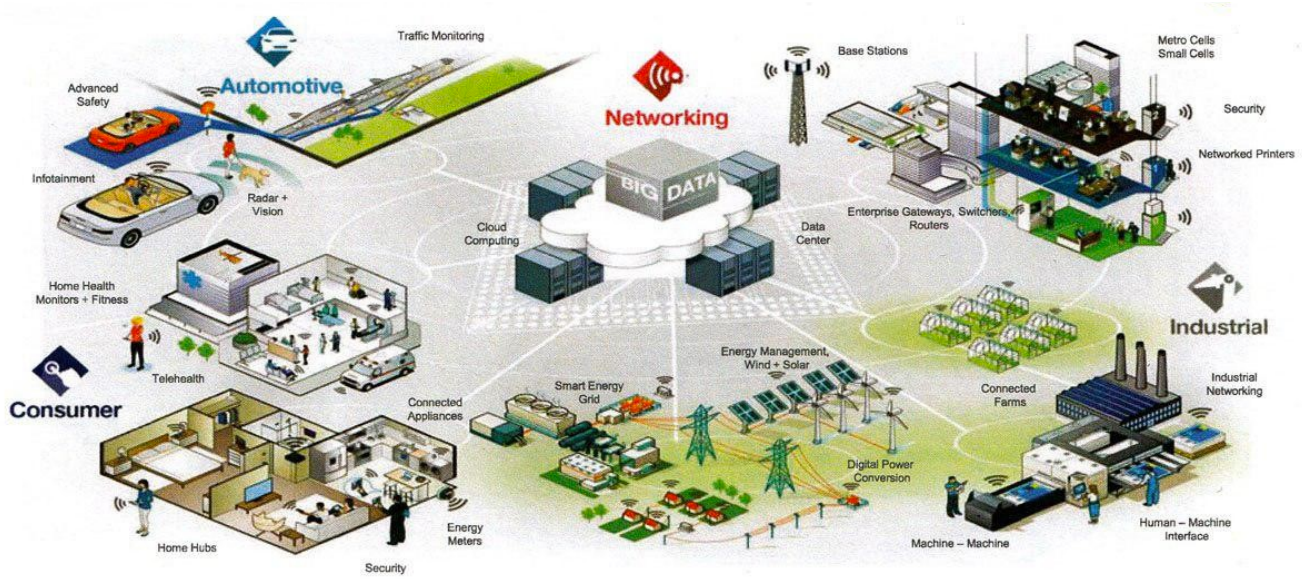
- Supply Chain
- Customer Service
- Human Resources
- Workplace

Internet of Things (IoT)

An ever-increasing number of sensors

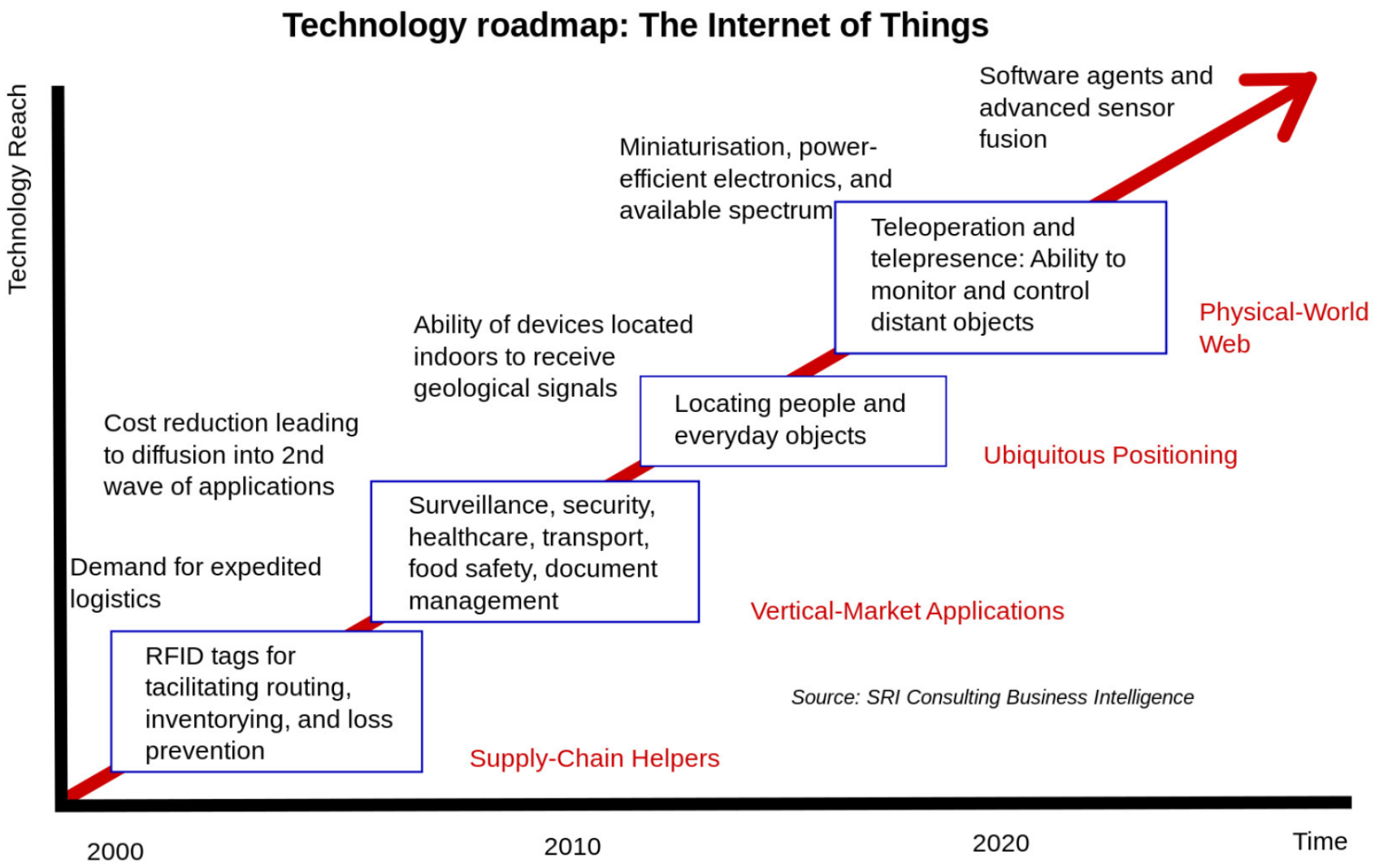
- Personal sensors (Fitbit, blood pressure)
- Household appliances (thermostat, refrigerator, water heater)
- Public infrastructure (bridges, water supply, parking)

Mostly used for informational purposes



Source: https://www.kernelsphere.com/role-sensors-internet-things/

Internet of Things (IoT)



Agent-to-Agent Commerce

Agents will automate a lot of shopping

- Discriminatory (or personalized) pricing
- They already automate a lot of B2B pricing

Trust / Privacy / Social Obstacles

- What if you find out your friends' agents got them better prices than yours?
- Do you want an Amazon agent to buy you stuff from Amazon if it might mean better prices?
- Do you want an agent reporting all your income/spending to the government if it might mean lower taxes?

Transparency

~~**No one really cares what Siri, Alexa, Cortana, … learn**~~

- ~~Most mistakes are amusing, annoying at worst~~

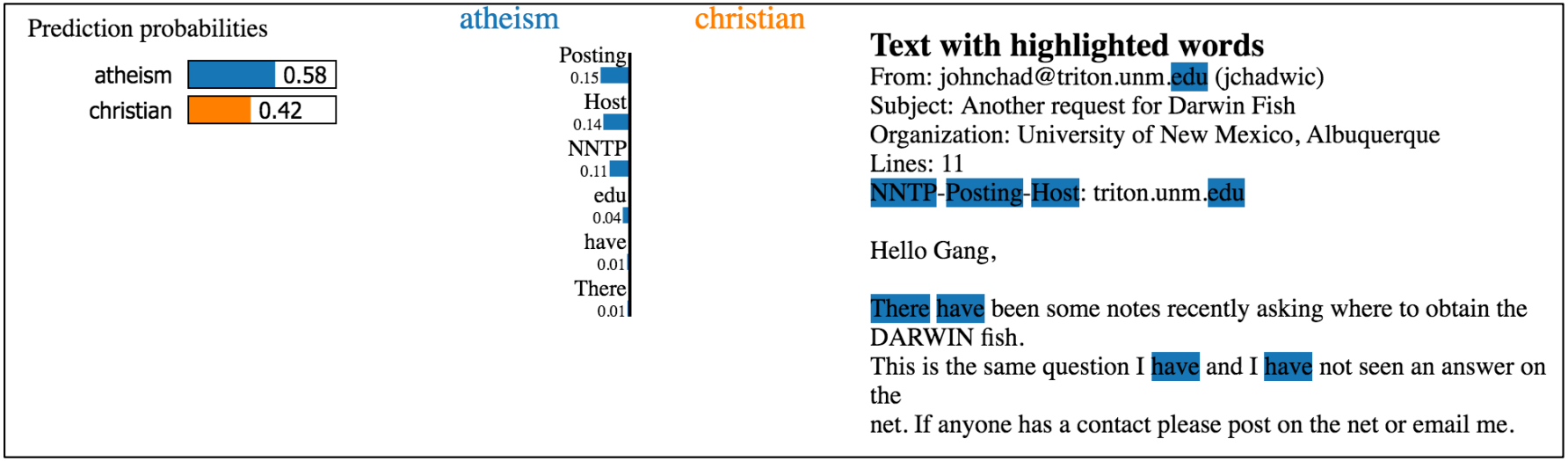
But what if mistakes become more critical?

- Self-driving cars
- TSA using game theory at LAX
- Image analysis for drones

Showing the DNN, SVM, HMM, MDP, … is not enough

- We want to be able to *understand* what the agent has learned
  - And *why* it learned it
- Can we develop AI methods that people can understand?
  - Many funding programs starting to look at this problem

Transparency



Source: Lime

AAAI-19 Keywords

Submission Groups

- AI and the Web (AIW)
- AI for Social Impact (AISI)
- Applications (APP)
- Cognitive Modeling (CM)
- Cognitive Systems (CS)
- Computational Sustainability (CSUS)
- Constraint Satisfaction and Optimization (CSO)
- Game Playing and Interactive Entertainment (GPIE)
- Game Theory and Economic Paradigms (GTEP)
- Heuristic Search and Optimization (HSO)
- Human-AI Collaboration (HAC)
- Humans and AI (HAI)
- Human-Computation and Crowd Sourcing (HCC)
- Knowledge Representation and Reasoning (KRR)
- Machine Learning (ML)
- Multiagent Systems (MAS)
- NLP (NLP)
- Planning, Routing, and Scheduling (PRS)
- Reasoning under Uncertainty (RU)
- Robotics (ROB)
- Vision (VIS)

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NUANCE

The Present of AI

Many free and open-source AI tools available

- It's easier than ever for you to do AI
- It's easier than ever for *anybody* to do AI

How can you distinguish yourself?

- Can you find new ways to apply these tools?
- Are there methods that no one else is using to solve a particular problem?
- Are there problems that no one else is solving?

Finally

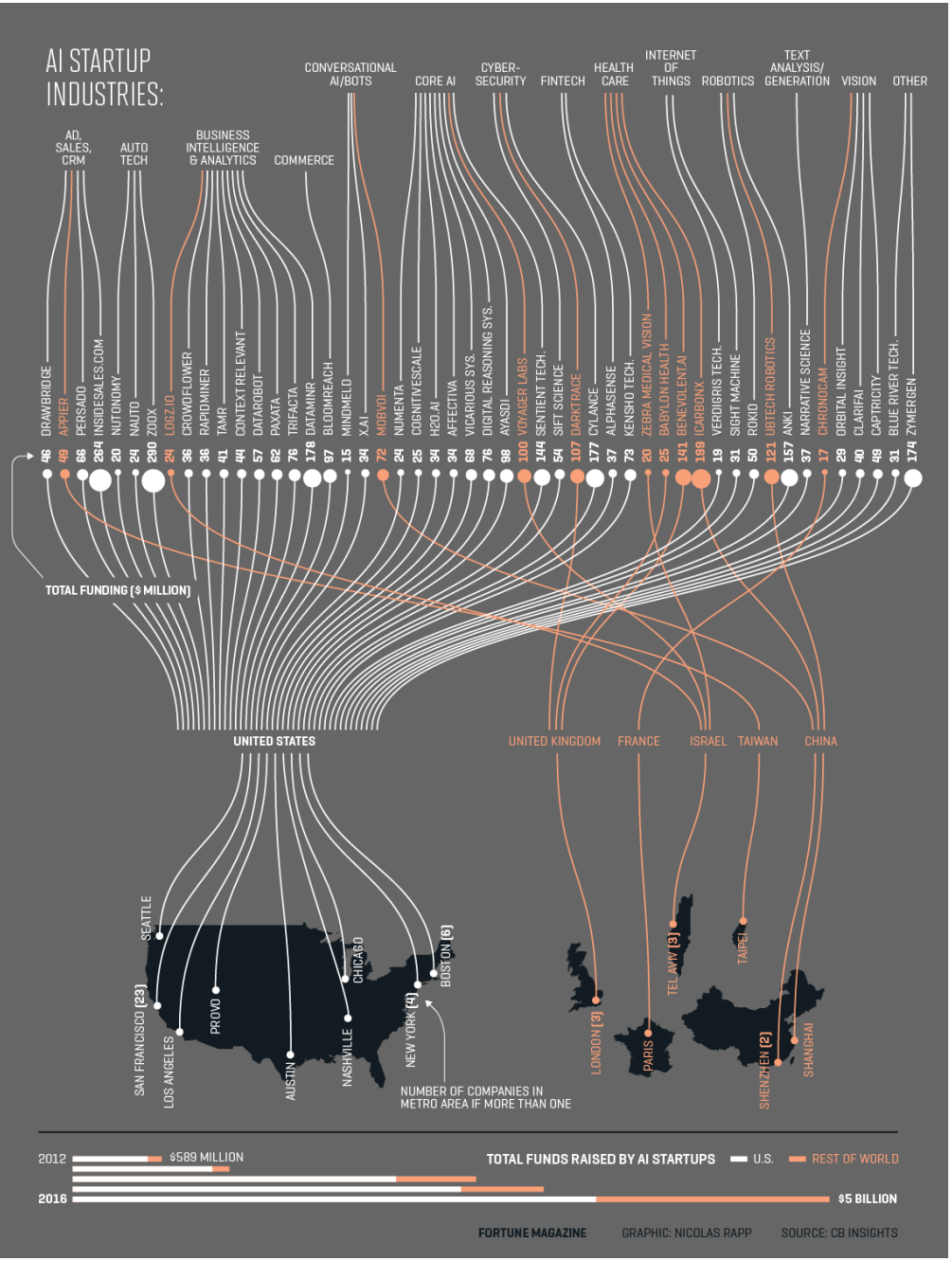
The best way to learn AI is to do it.

- Find something you want to automate in your life
  - Finding and summarizing related work
  - Vacuuming your room(s)
  - Choosing a playlist out of your music library
  - Selecting and scheduling exercises for regular workouts
- Automate it

AI might be the last job that AI can do.

"AI will have more 'profound' impact than electricity and fire."

-- Sundar Pichai


AI STARTUP INDUSTRIES:
AD, SALES, CRM
AUTO TECH
BUSINESS INTELLIGENCE & ANALYTICS
COMMERCE
CONVERSATIONAL AI/BOTS
CORE AI
CYBER-SECURITY
FINTECH
HEALTH CARE
INTERNET OF THINGS
ROBOTICS
TEXT ANALYSIS/ GENERATION
VISION
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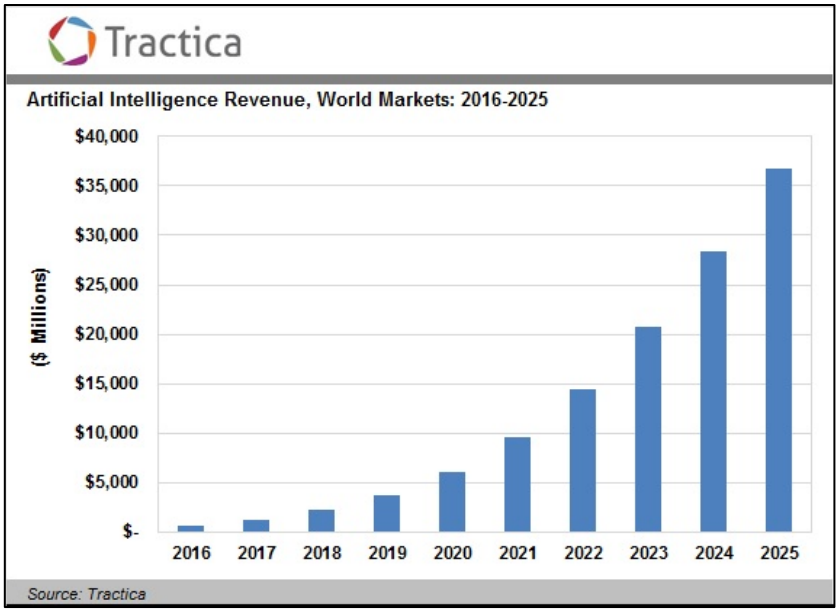
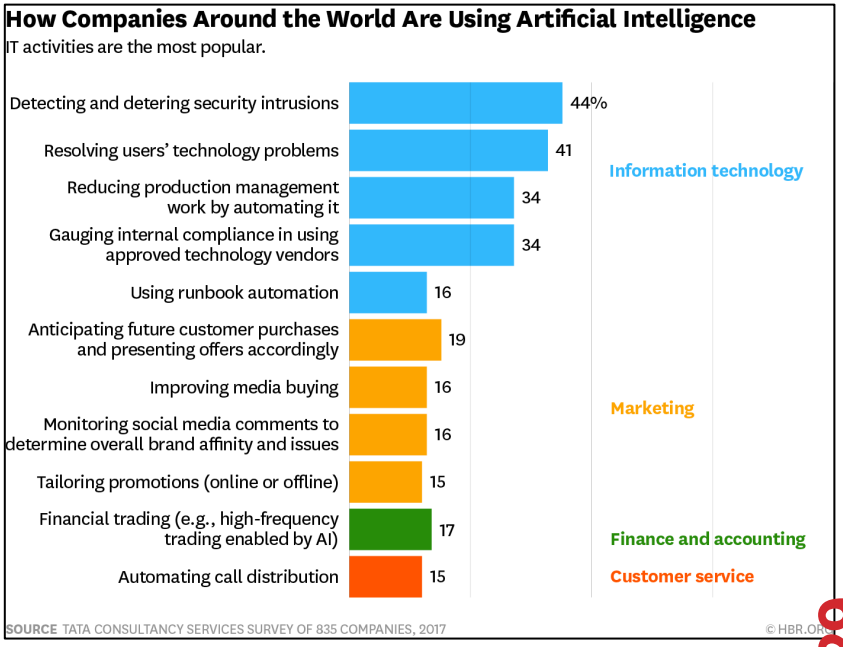
ANKI 157
NARRATIVE SCIENCE 37
CHRONODAM 17
ORBITAL INSIGHT 29
CLARIFAI 40
CAPTRICITY 49
BLUE RIVER TECH. 31
ZYMERGEN 174
TOTAL FUNDING ($ MILLION)
UNITED STATES
UNITED KINGDOM
FRANCE
ISRAEL
TAIWAN
CHINA
SEATTLE
SAN FRANCISCO [23]
LOS ANGELES
PROVO
AUSTIN
NASHVILLE
CHICAGO
NEW YORK [4]
BOSTON [6]
LONDON [3]
PARIS
TEL AVIV [3]
TAIPEI
SHENZHEN [2]
SHANGHAI
NUMBER OF COMPANIES IN METRO AREA IF MORE THAN ONE
2012
$589 MILLION
2016
$5 BILLION
TOTAL FUNDS RAISED BY AI STARTUPS
U.S.
REST OF WORLD
FORTUNE MAGAZINE
GRAPHIC: NICOLAS RAPP
SOURCE: CB INSIGHTS


Tractica
Artificial Intelligence Revenue, World Markets: 2016-2025
($ Millions)
$40,000
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$-
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Source: Tractica


How Companies Around the World Are Using Artificial Intelligence
IT activities are the most popular.
Detecting and detering security intrusions 44%
Resolving users' technology problems 41
Reducing production management work by automating it 34
Gauging internal compliance in using approved technology vendors 34
Using runbook automation 16
Anticipating future customer purchases and presenting offers accordingly 19
Improving media buying 16
Monitoring social media comments to determine overall brand affinity and issues 16
Tailoring promotions (online or offline) 15
Financial trading (e.g., high-frequency trading enabled by AI) 17
Automating call distribution 15
Information technology
Marketing
Finance and accounting
Customer service
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