CS 581 – ADVANCED ARTIFICIAL INTELLIGENCE

TOPIC: ARTIFICIAL INTELLIGENCE

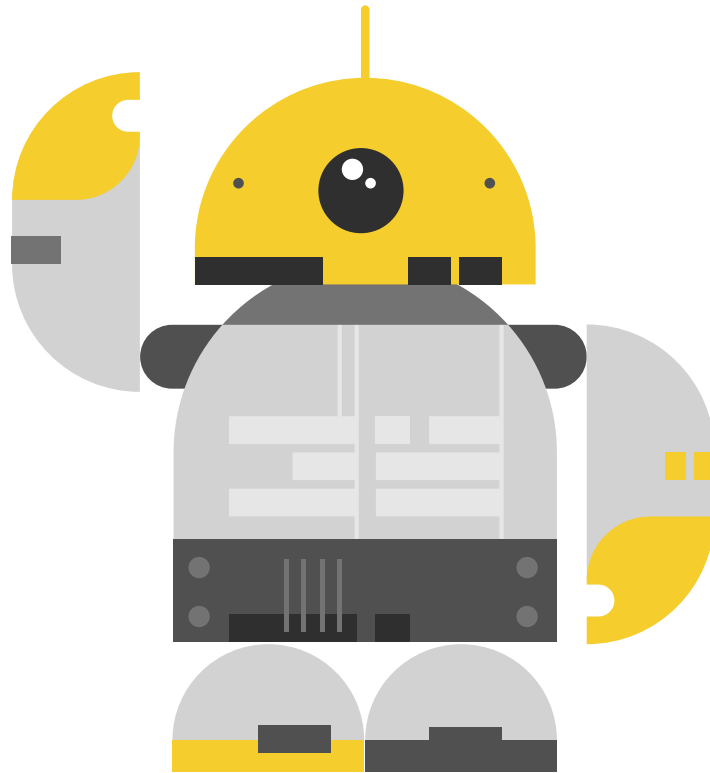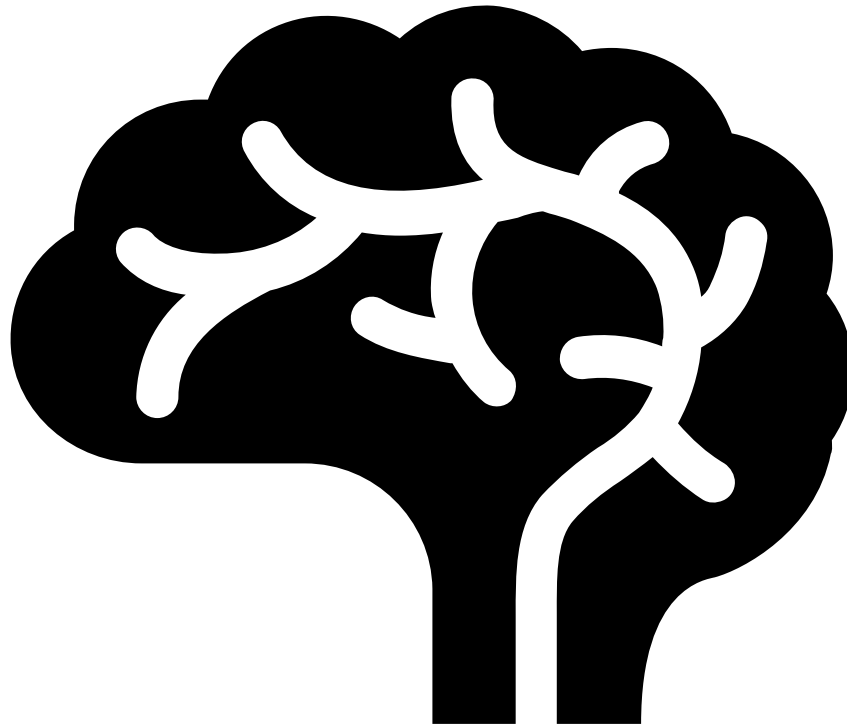**Mustafa Bilgic**

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🐦 https://twitter.com/bilgicm

WHAT IS ARTIFICIAL INTELLIGENCE?

WHAT IS INTELLIGENCE?

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LET'S ASK GOOGLE

- Artificial intelligence

  - https://www.google.com/search?q=define+artificial+intelligence

- Intelligence

  - https://www.google.com/search?q=define+intelligence

INTELLIGENT?

- Calculators
- Search engines
- Trees
- Ants
- Humans

INTELLIGENCE & COMPUTATION

- Does algebra require intelligence?

- Is a calculator intelligent?

- To be considered intelligent, does an entity need to be good at one thing? Many things? How many?

HUMAN BRAIN & COMPUTATION

- Can what a brain does be characterized as computation?

- Does a brain do more than just a computation?

INTELLIGENCE &

- Learning
- Creativity
- Sense of humor
- Emotions
- Consciousness

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BEGINNINGS OF AI

- Greek mythology – Talos

- …

- Initial computational discussions of an artificial brain – 1940s
  - Artificial neurons (Pitts and McColloch)

- Imitation game – 1950
  - Turing test (Alan Turing)

- The term AI was coined – 1956
  - Dartmouth workshop (John McCarthy)

THE TURING TEST

- Turing, A. (1950). Computing machinery and intelligence. *Mind,* 59, 433-460.

- The imitation game
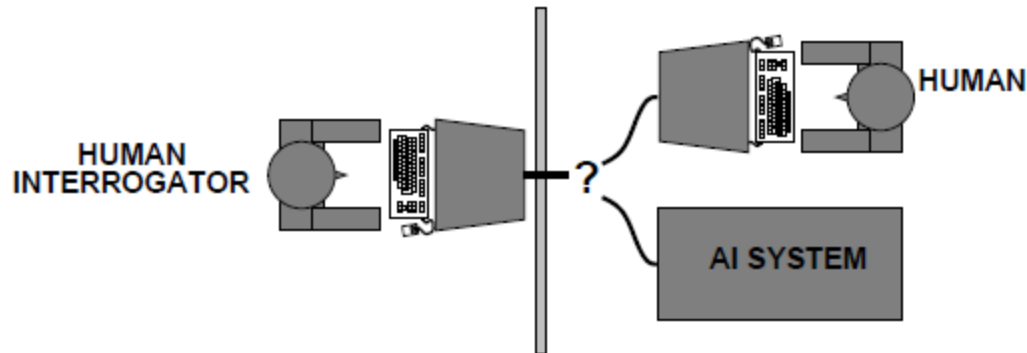
- Loebner prize https://en.wikipedia.org/wiki/Loebner_Prize

DARTMOUTH WORKSHOP – 1956

- The workshop where the term Artificial Intelligence was coined

  - https://en.wikipedia.org/wiki/Dartmouth_workshop

- John McCarthy (1917 – 2011)

  - http://jmc.stanford.edu/

- "What is AI?" by McCarthy:
  http://jmc.stanford.edu/articles/whatisai.html

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HUMANLY VS. RATIONALLY & THINKING VS. ACTING

	Humanly	Rationally
Think	Thinking humanly	Thinking rationally
Act	Acting humanly	Acting rationally

CAN MACHINES THINK?

"The question of whether machines can think … is about as relevant as the question of whether submarines can swim."

Edsger Dijkstra (1984)

THE AI EFFECT

- "Every time we figure out a piece of it, it stops being magical; we say, 'Oh, that's just a computation.'"

- "AI is whatever hasn't been done yet."

Quotes from https://en.wikipedia.org/wiki/AI_effect

WEAK VS STRONG AI

- Weak AI (Narrow AI)
  - Build AI systems that are really good at one task
  - Most, if not all, of the current systems
- Strong AI (Artificial General Intelligence)
  - Build AI systems that are generally intelligent
  - Challenge: the whole is greater than the sum of its parts

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A Bit of History

- 1956 – the birth of the term AI
- 1950s/1960s – successes in microworlds
  - GPS, checkers, Lisp, …
- 1970s – A dose of reality
  - Combinatorial explosion, limitations of perceptrons, …
- 1980s
  - Expert systems
  - The return of neural networks
  - Probabilistic reasoning; Bayesian networks
- 1990s
  - More computing power; e.g., Deep Blue beats Kasparov
  - Many advances in ML; e.g., support vector machines
- 2000s
  - Data mining; AI on the web
- 2010s
  - Big data
  - Deep learning
- 2020s
  - ?

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AI Winter

- Hype – Disappointment – Funding Cuts – Renewed interest
  - https://en.wikipedia.org/wiki/AI_winter
- 1966
  - National Research Council report: "machine translation was more expensive, less accurate and slower than human translation"
- 1969
  - "Perceptrons" book; showed the limits of perceptrons, the building blocks of neural networks
- 1970s
  - The Lighthill report at UK; the problem of combinatorial explosion and intractability
  - Amendment to DARPA's funding; required "mission-oriented" research rather than "basic" research
- 1987
  - The beginning of the collapse of the LISP machine and expert systems
- 2020s
  - ?

WHAT IS DIFFERENT NOW?

1. Data
   - We generate **so** much data
   - We can and do store **all** of it
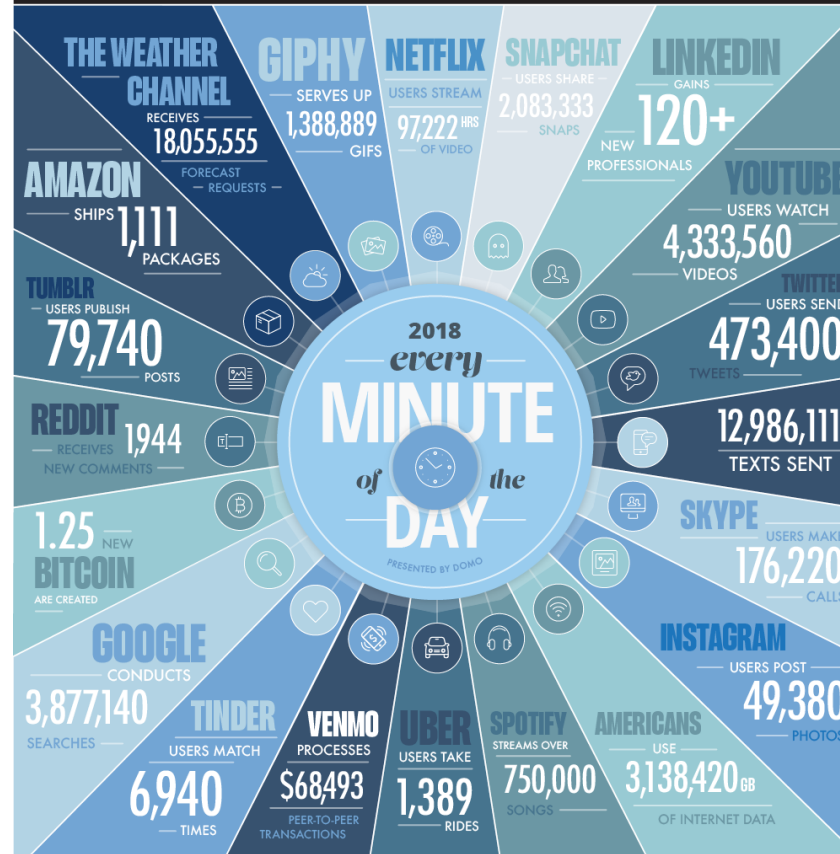
2. Computing power
   - Moore's law: "the number of transistors in a integrated dense circuit doubles about every two years"
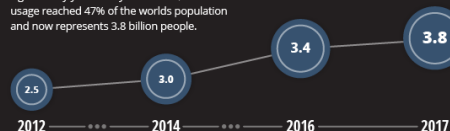   - GPU computation

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DATA NEVER SLEEPS 6.0

How much data is generated *every minute?*

There's no way around it: big data just keeps getting bigger. The numbers are staggering, but they're not slowing down. By 2020, it's estimated that for every person on earth, 1.7 MB of data will be created every second. In our 6th edition of Data Never Sleeps, we once again take a look at how much data is being created all around us every single minute of the day—and we have a feeling things are just getting started.

THE WEATHER CHANNEL RECEIVES 18,055,555 FORECAST REQUESTS

GIPHY SERVES UP 1,388,889 GIFS

NETFLIX USERS STREAM 97,222 HRS OF VIDEO

SNAPCHAT USERS SHARE 2,083,333 SNAPS

LINKEDIN GAINS 120+ NEW PROFESSIONALS

AMAZON SHIPS 1,111 PACKAGES

YOUTUBE USERS WATCH 4,333,560 VIDEOS

TUMBLR USERS PUBLISH 79,740 POSTS

TWITTER USERS SEND 473,400 TWEETS

REDDIT RECEIVES 1,944 NEW COMMENTS

12,986,111 TEXTS SENT

1.25 NEW **BITCOIN** ARE CREATED

SKYPE USERS MAKE 176,220 CALLS

GOOGLE CONDUCTS 3,877,140 SEARCHES

INSTAGRAM USERS POST 49,380 PHOTOS

TINDER USERS MATCH 6,940 TIMES

VENMO PROCESSES $68,493 PEER-TO-PEER TRANSACTIONS

UBER USERS TAKE 1,389 RIDES

SPOTIFY STREAMS OVER 750,000 SONGS

AMERICANS USE 3,138,420 GB OF INTERNET DATA

2018 every MINUTE of the DAY PRESENTED BY DOMO

The world's internet population is growing significantly year-over-year. In 2017, internet usage reached 47% of the worlds population and now represents 3.8 billion people.

2.5 (2012) — 3.0 (2014) — 3.4 (2016) — 3.8 (2017)

GLOBAL INTERNET POPULATION GROWTH 2012–2017 (IN BILLIONS)

The ability to make data-driven decisions is crucial to any business. With each click, swipe, share, and like, a world of valuable information is created. Domo puts the power to make those decisions right into the palm of your hand by connecting your data and your people at any moment, on any device, so they can make the kind of decisions that make an impact.

Learn more at domo.com

SOURCES: STATISTA, LINKEDIN, INTERNET LIVE STATS, EXPANDED RAMBLINGS, SLASH FILM, RIAA, BUSINESS OF APPS, INTERNATIONAL TELECOMMUNICATIONS UNION, INTERNATIONAL DATA CORPORATION
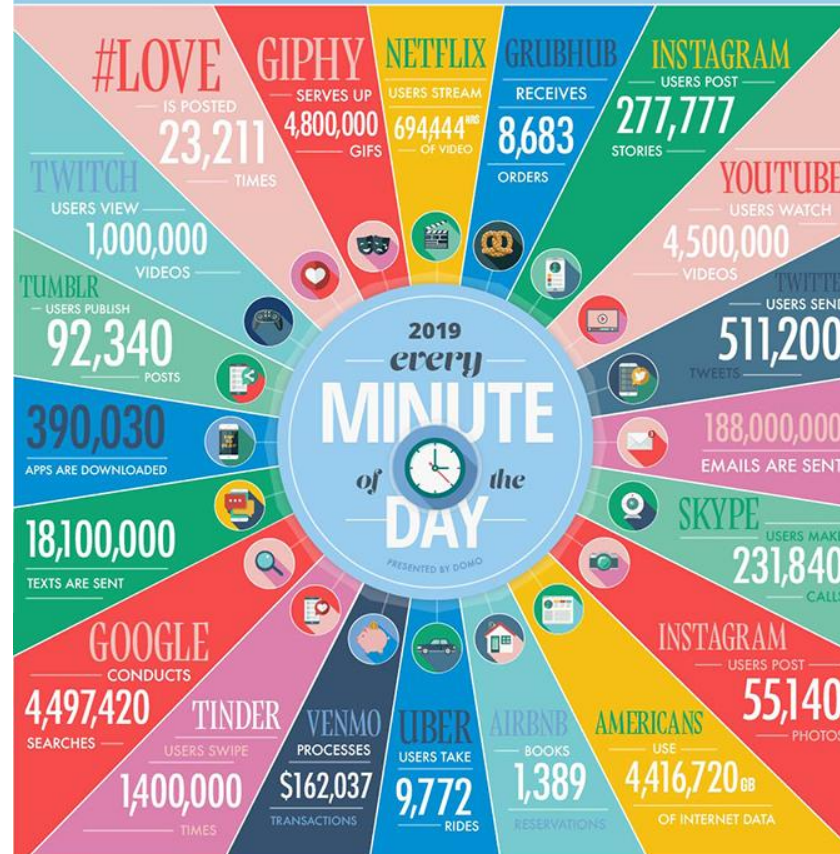
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Moore's Law – The number of transistors on integrated circuit chips (1971-2016)

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years.
This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are
strongly linked to Moore's law.

Transistor count (y-axis)

- 20,000,000,000
- 10,000,000,000
- 5,000,000,000
- 1,000,000,000
- 500,000,000
- 100,000,000
- 50,000,000
- 10,000,000
- 5,000,000
- 1,000,000
- 500,000
- 100,000
- 50,000
- 10,000
- 5,000
- 1,000

Chip labels (left to right, approximately):

Intel 4004, Intel 8008, TMS 1000, RCA 1802, Motorola 6800, Intel 8080, MOS Technology 6502, Zilog Z80, Intel 8085, Motorola 6809, Intel 8086, Intel 8088, Motorola 68000, WDC 65C02, WDC 65C816, Intel 80186, Intel 80286, Motorola 68020, Intel 80386, Novix NC4016, ARM 1, ARM 2, TI Explorer's 32-bit Lisp machine chip, Intel i960, DEC WRL MultiTitan, ARM 3, ARM 6, Intel 80486, R4000, ARM700, SA-110, Pentium, Pentium Pro, AMD K5, AMD K6, Pentium II Klamath, Pentium II Deschutes, Pentium III Katmai, ARM 9TDMI, AMD K6-III, AMD K7, Pentium II Mobile Dixon, Pentium III Coppermine, Pentium 4 Willamette, Pentium III Tualatin, Pentium 4 Northwood, Barton, Atom, ARM Cortex-A9, AMD K8, Pentium 4 Prescott, Pentium 4 Prescott-2M, Itanium 2 McKinley, Cell, Pentium D Smithfield, Pentium 4 Cedar Mill, Core 2 Duo Allendale, Itanium 2 Madison 6M, Core 2 Duo Wolfdale 3M, Core 2 Duo Conroe, Core 2 Duo Wolfdale, Itanium 2 with 9 MB cache, AMD K10 quad-core 2M L3, Core i7 (Quad), Pentium D Presler, POWER6, Apple A7 (dual-core ARM64 "mobile SoC"), Dual-core Itanium 2, Six-core Xeon 7400, 8-core Xeon Nehalem-EX, Quad-core + GPU Core i7 Haswell, Quad-core + GPU GT2 Core i7 Skylake K, Duo-core + GPU Iris Core i7 Broadwell-U, 8-core Core i7 Haswell-E, Apple A8X (tri-core ARM64 "mobile SoC"), 12-core POWER8, 61-core Xeon Phi, IBM z13, 15-core Xeon Ivy Bridge-EX, Xbox One main SoC, 22-core Xeon Broadwell-E5, 18-core Xeon Haswell-E5, IBM z13 Storage Controller, SPARC M7

Year of introduction (x-axis): 1970, 1972, 1974, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016

RISKS AND BENEFITS

- AI is a tool
- Benefits
  - Solve challenging problems (diseases, climate change, resource shortages, …)
- Risks
  - Lethal autonomous weapons
  - Surveillance
  - Manipulation
  - Biased decision making (race, gender, religion, …)
  - Unemployment
  - Safety (driving cars)
  - Cybersecurity
  - …

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AI ROADMAP

- https://cra.org/ccc/visioning/visioning-activities/2018-activities/artificial-intelligence-roadmap/

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- Search

- Probabilistic reasoning

- Decision making

- Machine learning

- Knowledge representation

- Ethics and safety

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