

CS 581 – ADVANCED ARTIFICIAL INTELLIGENCE

TOPIC: ARTIFICIAL INTELLIGENCE



Mustafa Bilgic

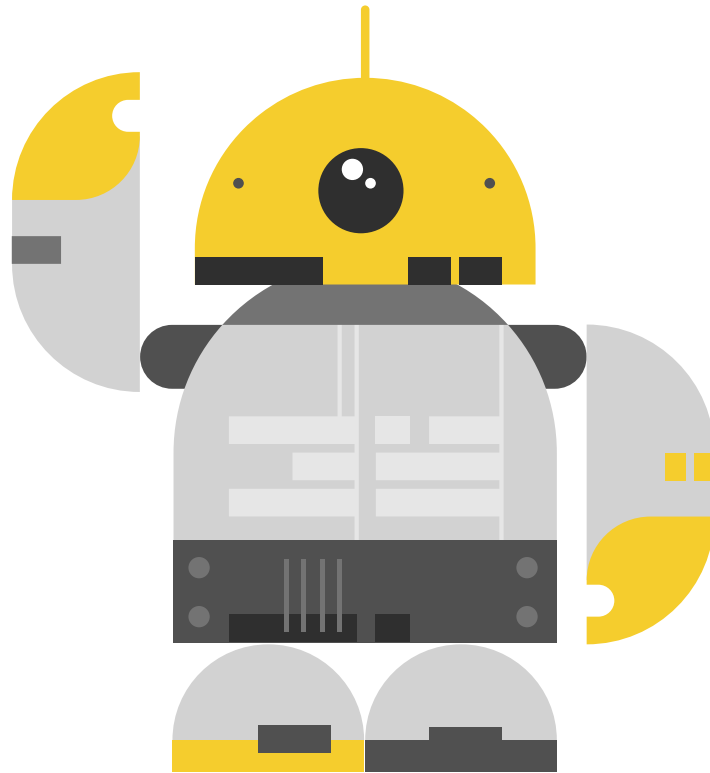


<http://www.cs.iit.edu/~mbilgic>

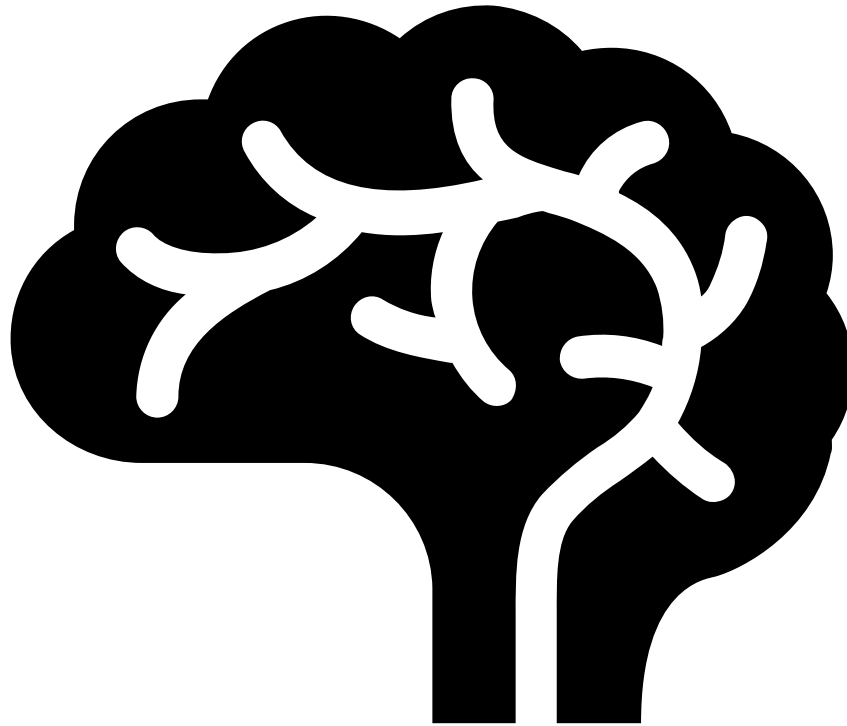


<https://twitter.com/bilgicm>

WHAT IS ARTIFICIAL INTELLIGENCE?



WHAT IS INTELLIGENCE?



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
- Google
- Trees
- Ants
- Humans
- AlphaGo
- ChatGPT

INTELLIGENCE & COMPUTATION

- Does algebra require intelligence?
- 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 perform more than just computation?
- Some reading materials (and many more are out there)
 - <https://www.theguardian.com/science/2020/feb/27/why-your-brain-is-not-a-computer-neuroscience-neural-networks-consciousness>
 - <https://www.technologyreview.com/2021/08/25/1030861/is-human-brain-computer/>
 - <https://simons.berkeley.edu/news/brain-and-computation>

INTELLIGENCE &

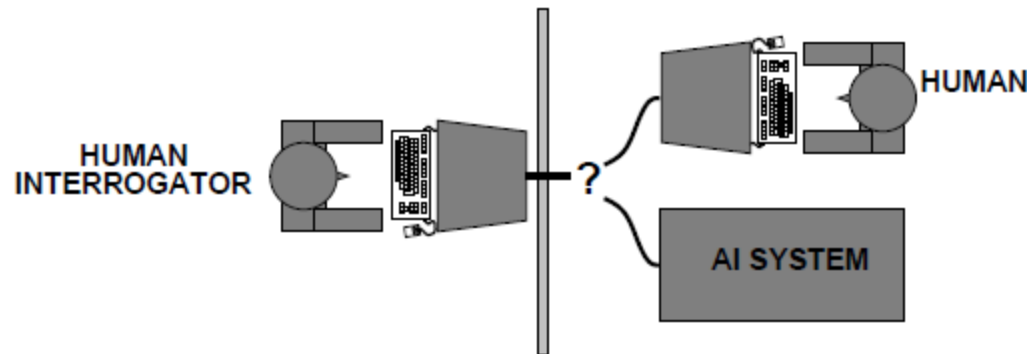
- Learning
- Creativity
- Sense of humor
- Emotions
- Consciousness

BEGINNINGS OF AI

- Greek mythology – Talos
 - <https://news.stanford.edu/2019/02/28/ancient-myths-reveal-early-fantasies-artificial-life/>
- [skipping a few years]
- Initial computational discussions of an artificial brain – 1940s
 - Artificial neurons (Pitts and McCulloch)
 - <https://www.cs.cmu.edu/~./epxing/Class/10715/reading/McCulloch.and.Pitts.pdf>
- Imitation game – 1950
 - Turing test (Alan Turing)
 - <https://academic.oup.com/mind/article/LIX/236/433/986238>
- The term AI was coined – 1956
 - Dartmouth workshop (John McCarthy)
 - https://en.wikipedia.org/wiki/Dartmouth_workshop

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>

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

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
 - ?

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

DATA NEVER SLEEPS

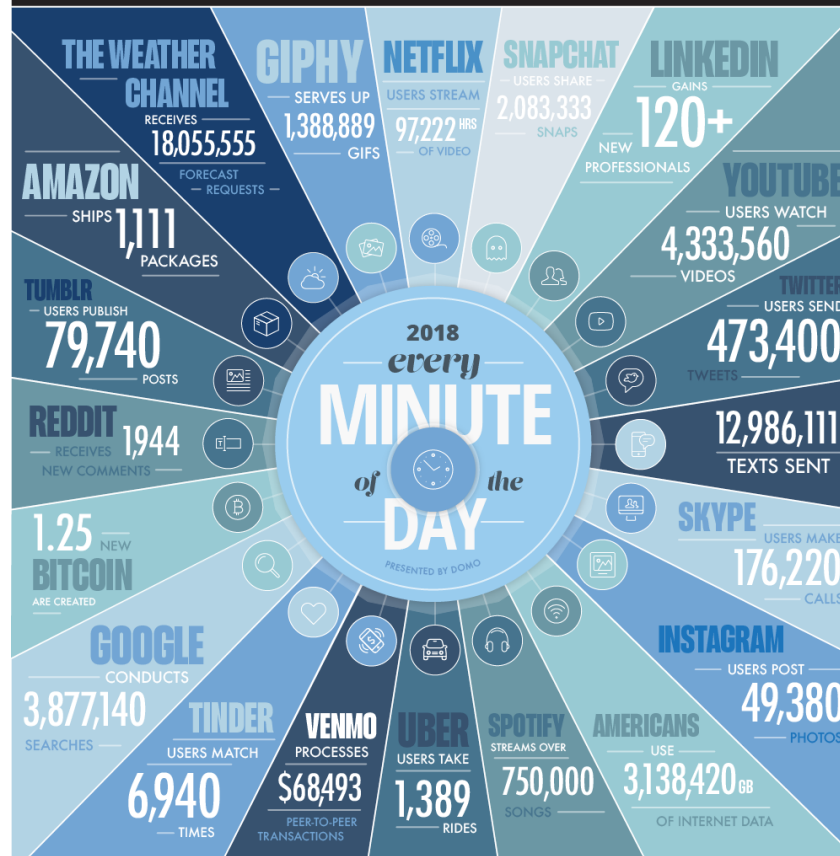
- <https://www.domo.com/data-never-sleeps>

DOMO

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



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

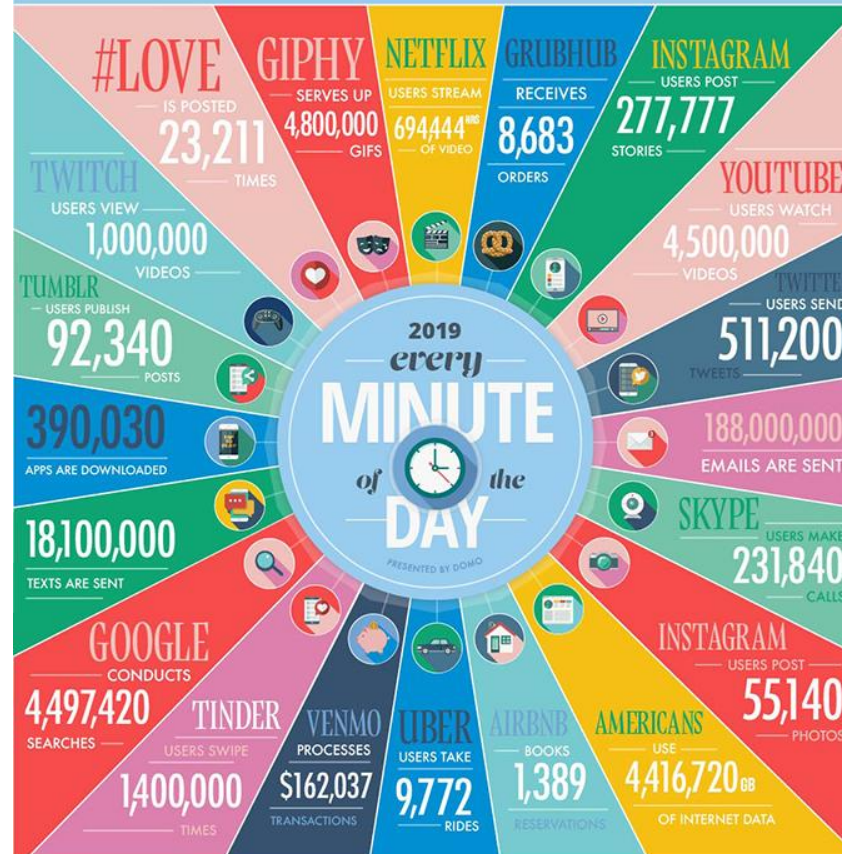




DATA NEVER SLEEPS 7.0

How much data is generated *every minute*?

There's no way around it: big data just keeps getting bigger. The numbers are staggering, and they're not slowing down. By 2020, there will be 40x more bytes of data than there are stars in the observable universe. In our 7th edition of Data Never Sleeps, we bring you the latest stats on how much data is being created in every digital minute — and the numbers are staggering.



The world's internet population is growing significantly year-over-year. As of January 2019, the internet reaches 56.1% of the world's population and now represents 4.39 billion people — a 9% increase from January 2018.



GLOBAL INTERNET POPULATION GROWTH 2012-2018
(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, INTERNET LIVE STATS, EXPANDED RAMBLINGS, NATIONAL ASSOCIATION OF CITY TRANSPORTATION OFFICIALS, WIRED

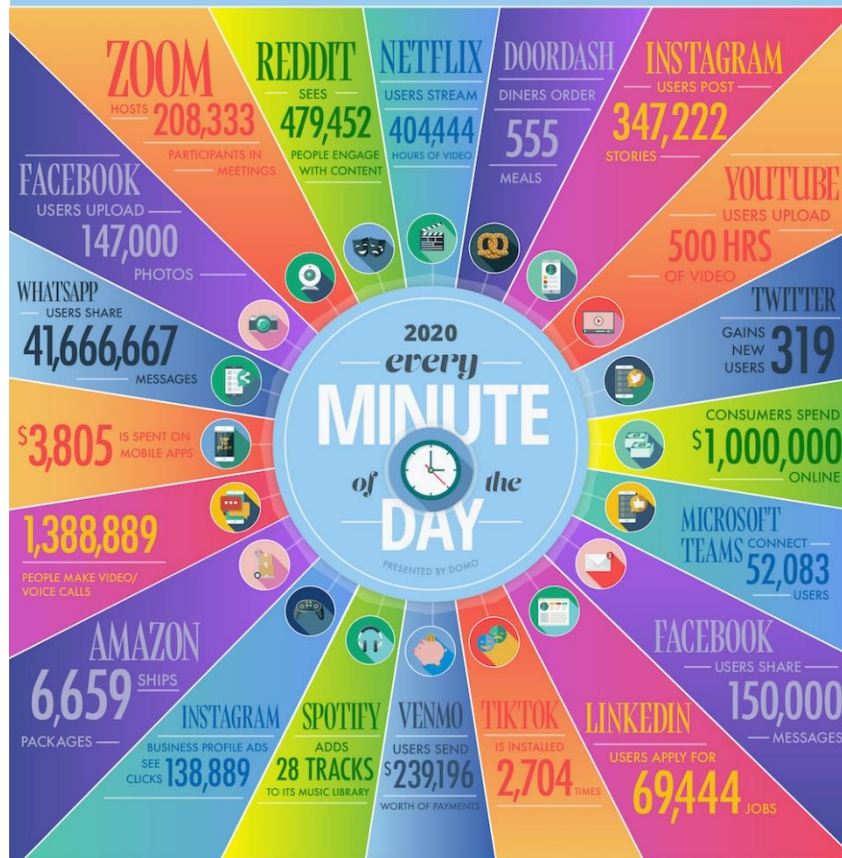


DOMO

DATA NEVER SLEEPS 8.0

How much data is generated every minute?

In 2020, the world changed fundamentally—and so did the data that makes the world go round. As COVID-19 swept the globe, nearly every aspect of life—from work to working out—moved online, and people depended more and more on apps and the Internet to socialize, educate and entertain ourselves. Before quarantine, just 15% of Americans worked from home. Now over half do. And that's not the only big shift. In our 8th edition of Data Never Sleeps, we bring you the latest stats on how much data is being created in every digital minute—a trend that shows no sign of stopping.



The world's Internet population is growing significantly year over year. As of April 2020, the Internet reaches 59% of the world's population and now represents 4.57 billion people — a 6% increase from January 2019.



GLOBAL INTERNET POPULATION GROWTH 2014–2020
(IN BILLIONS)

As the world changes, businesses need to change with the times—and that requires data. Every click, swipe, share or like tells you something about your customers and what they want, and Domo is here to help your business make sense of all of it. Domo gives you the power to make data-driven decisions at any moment, on any device, so you can make smart choices in a rapidly changing world.

Learn more at domo.com

SOURCE: STATISTA, VITAL CAPITALIST, BUSINESS INSIDER, GAME/SPOT, TECHCRUNCH, OMNICORE AGENCY, DOORDASH, BUSINESS OF APPS, NEW YORK TIMES, MUSIC BUSINESS WORLDWIDE, INC., THE VERGE, INC., HOOKSTRUT, BUSTIN STOUT, REDCUT, LEBES, AMAZON, VOR





Data Never Sleeps 9.0

How much data is generated every minute?

The 2020 pandemic upended everything, from how we engage with each other to how we engage with brands and the digital world. At the same time, it transformed how we eat, how we work and how we entertain ourselves. Data never sleeps and it shows no signs of slowing down. In our 9th edition of the "Data Never Sleeps" infographic, we bring you a glimpse of how much data is created every digital minute in our increasingly data-driven world.



As of July 2021, the internet reaches 65% of the world's population and now represents 5.17 billion people—a 10% increase from January 2021. Of this total, 92.6 percent accessed the internet via mobile devices. According to Statista, the total amount of data consumed globally in 2021 was 79 zettabytes, an annual number projected to grow to over 180 zettabytes by 2025.

Global Internet Population Growth (IN BILLIONS)



As the world changes, businesses need to change too—and that requires data. Domo gives you the power to make data-driven decisions at any moment, on any device, so that you can make smart choices in a rapidly changing world. Every click, swipe, share, or like tells you something about your customers and what they want, and Domo is here to help you and your business make sense of all of it.

Learn more at domo.com

SOURCES: LOCAL IQ, BUSINESS OF APPS, DUSTIN STOUT, HOOTSUITE, SPANFORD BANKING, INTERNET WORLD STATS, STATISTA, CBIE, BRANDWATCH, KILL THE CABLE BILL, YOUTUBE, KINISTA, THE VERGE, ADVERTISEMENT COMMUNICATION, A CASE ANALYSIS APPROACH, INTERNET LIVE STATS, SODA, STATISTA

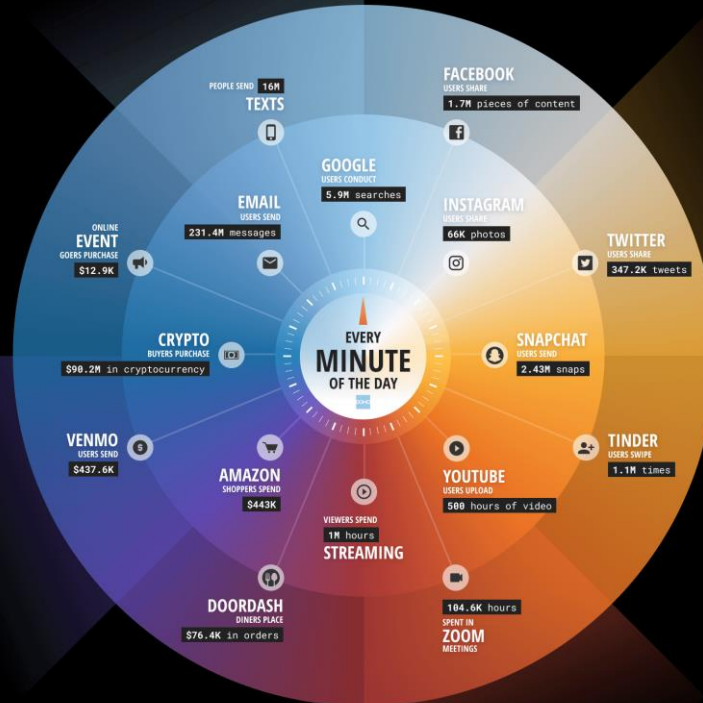




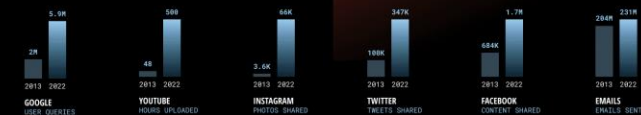
DATA NEVER SLEEPS 10.0

Over the last ten years, digital engagement through social media, streaming content, online purchasing, peer-to-peer payments and other activities has increased hundreds and even thousands of percentage points. While the world has faced a pandemic, economic ups and downs, and global unrest, there has been one constant in society:

our increasing use of new digital tools to support our personal and business needs, from connecting and communicating to conducting transactions and business. In this 10th annual "Data Never Sleeps" infographic, we share a glimpse at just how much data the internet produces each minute from some of this activity, marveling at the volume and variety of information that has been generated.



DATA NEVER SLEEPS 1.0 VS. 10.0



GLOBAL INTERNET POPULATION GROWTH IN BILLIONS



As of April 2022, the internet reaches 63% of the world's population, representing roughly 5 billion people. Of this total, 4.65 billion - over 93 percent - were social media users. According to Statista, the total amount of data predicted to be created, captured, copied and consumed globally in 2022 is 97 zettabytes, a number projected to grow to 181 zettabytes by 2025.

To succeed in an increasingly digital world where the volume of data created keeps accelerating, businesses need the right tools to put that data to work right where work gets done. Domo gives you the power to rapidly unlock value from all your data, regardless of where it lives, and drive actions across your organization that will improve business outcomes. Every click, swipe, share, or like tells a story, and Domo helps you do something powerful with it.

LEARN MORE AT DOMO.COM

SOURCES

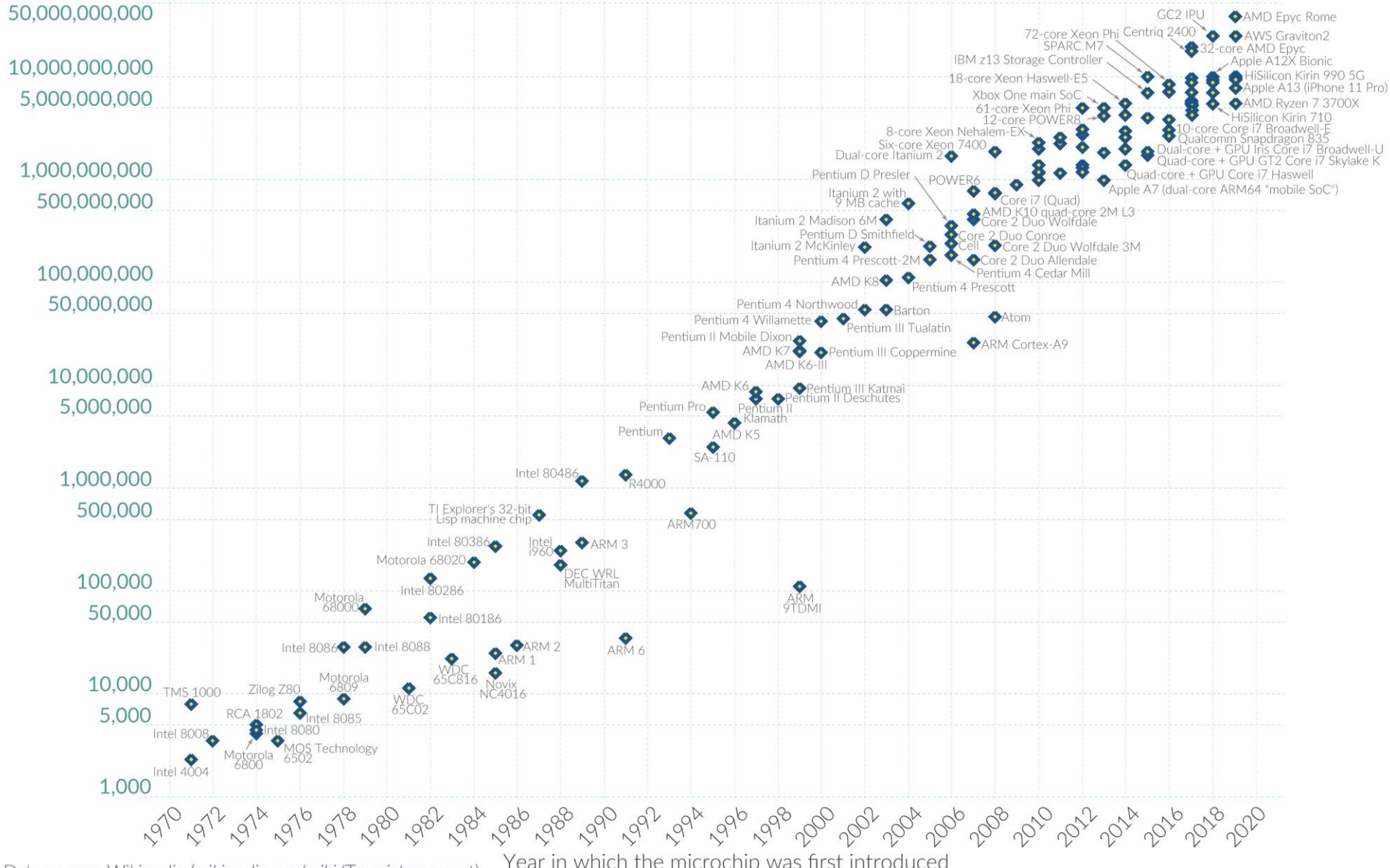
Global Media Insights, Oberlo, Hootsuite, Earthevents, Matthew Woodward.co.uk, Web Tribunal, Deadline.com, Local IQ, Business of Apps, Query Sprout, Young and the Rubicam, eMarketer, Statista, Domo, TechCrunch, Statista, Data Never Sleeps 1.0



Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

Transistor count



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
 - ...

AI ROADMAP

- <https://cra.org/cccvisioning/visioning-activities/2018-activities/artificial-intelligence-roadmap/>

CS 581

- Search
- Probabilistic reasoning
- Decision making
- Machine learning
- Knowledge representation
- Ethics and safety