CS 581 – Advanced Artificial Intelligence

Topic: Artificial Intelligence

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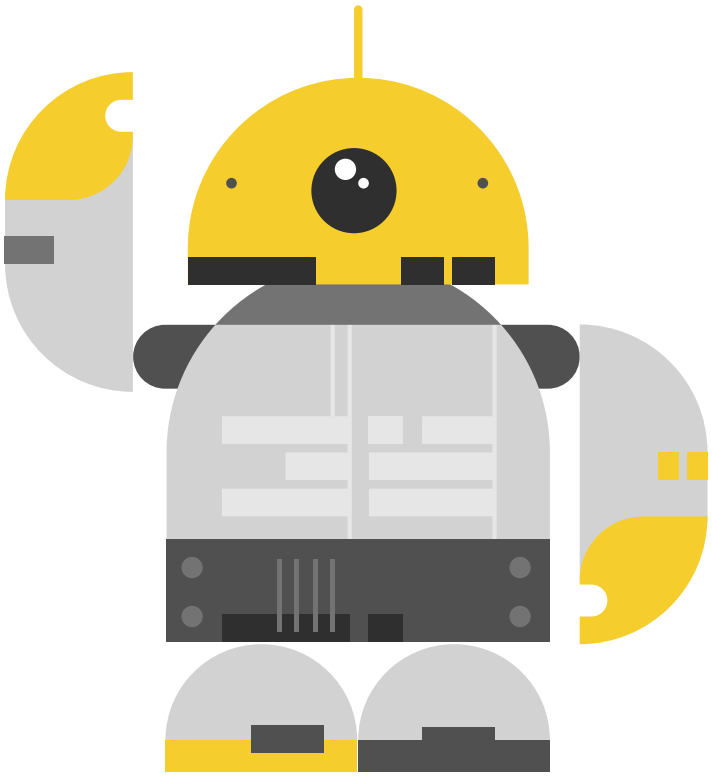
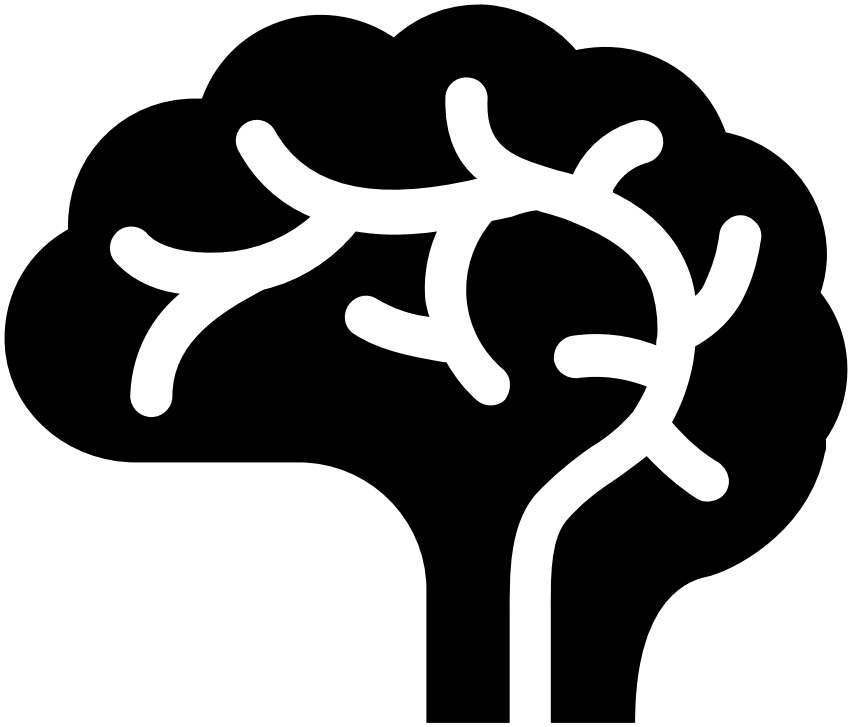
What is Artificial Intelligence?



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

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 perform more than just computation?

Intelligence &

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

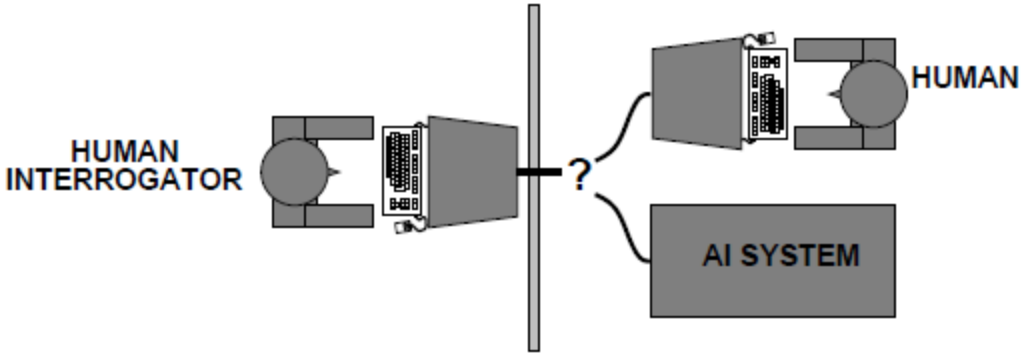
Beginnings of AI

- Greek mythology – Talos
- …
- Initial computational discussions of an artificial brain – 1940s
  - Artificial neurons (Pitts and McCulloch)
- 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

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

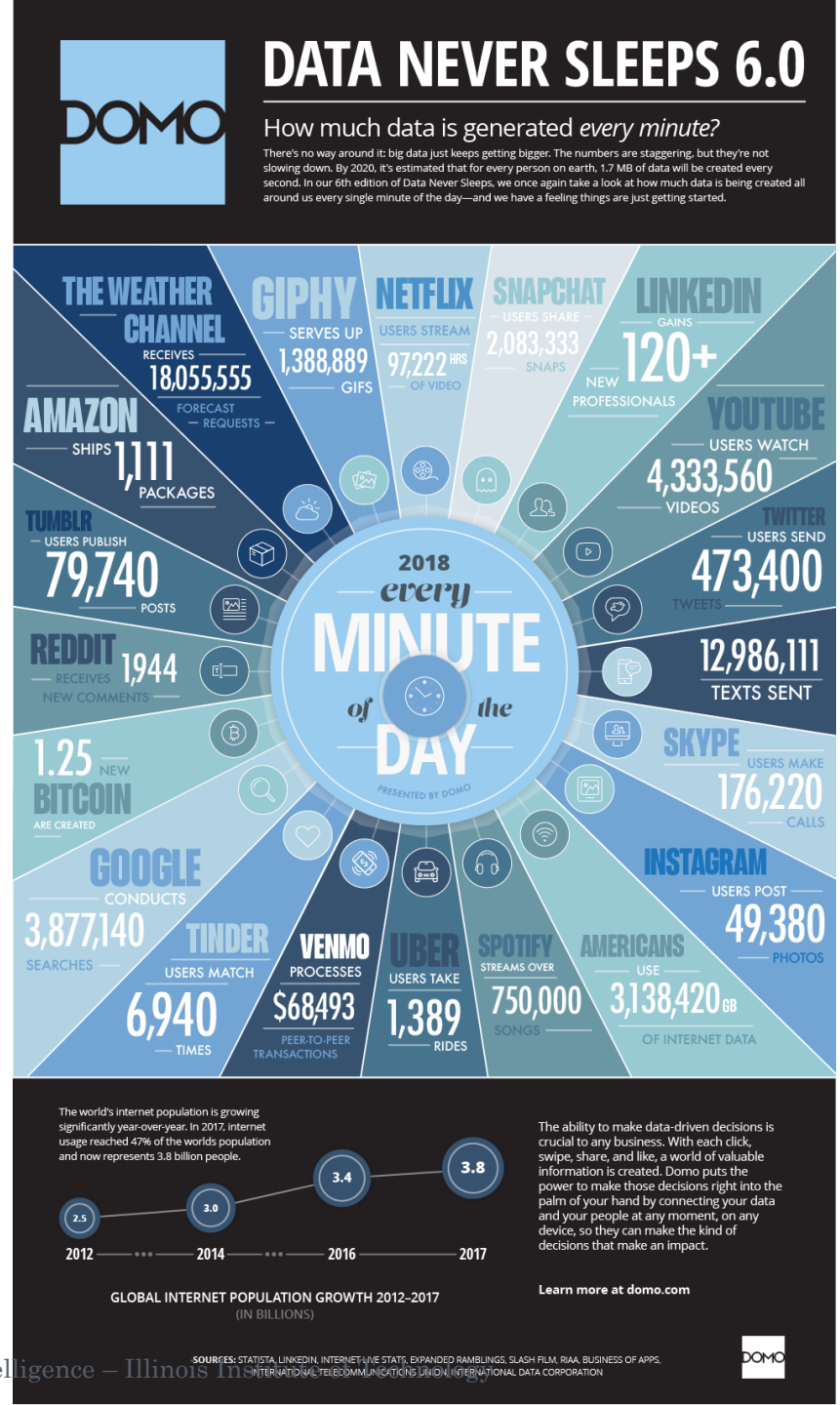
- 1956 – the birth of the term AI
- 1950s/1960s – successes in microworlds
  - GPS, checkers, Lisp, …
- 1970s – A dose of reality
  - Combinatorial explosion, limitations of perceptrons, …
- 1980s
  - Expert systems
  - The return of neural networks
  - Probabilistic reasoning; Bayesian networks
- 1990s
  - 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


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 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
2018
every
MINUTE
of the
DAY
PRESENTED BY DOMO
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
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
3.0
3.4
3.8
2012
2014
2016
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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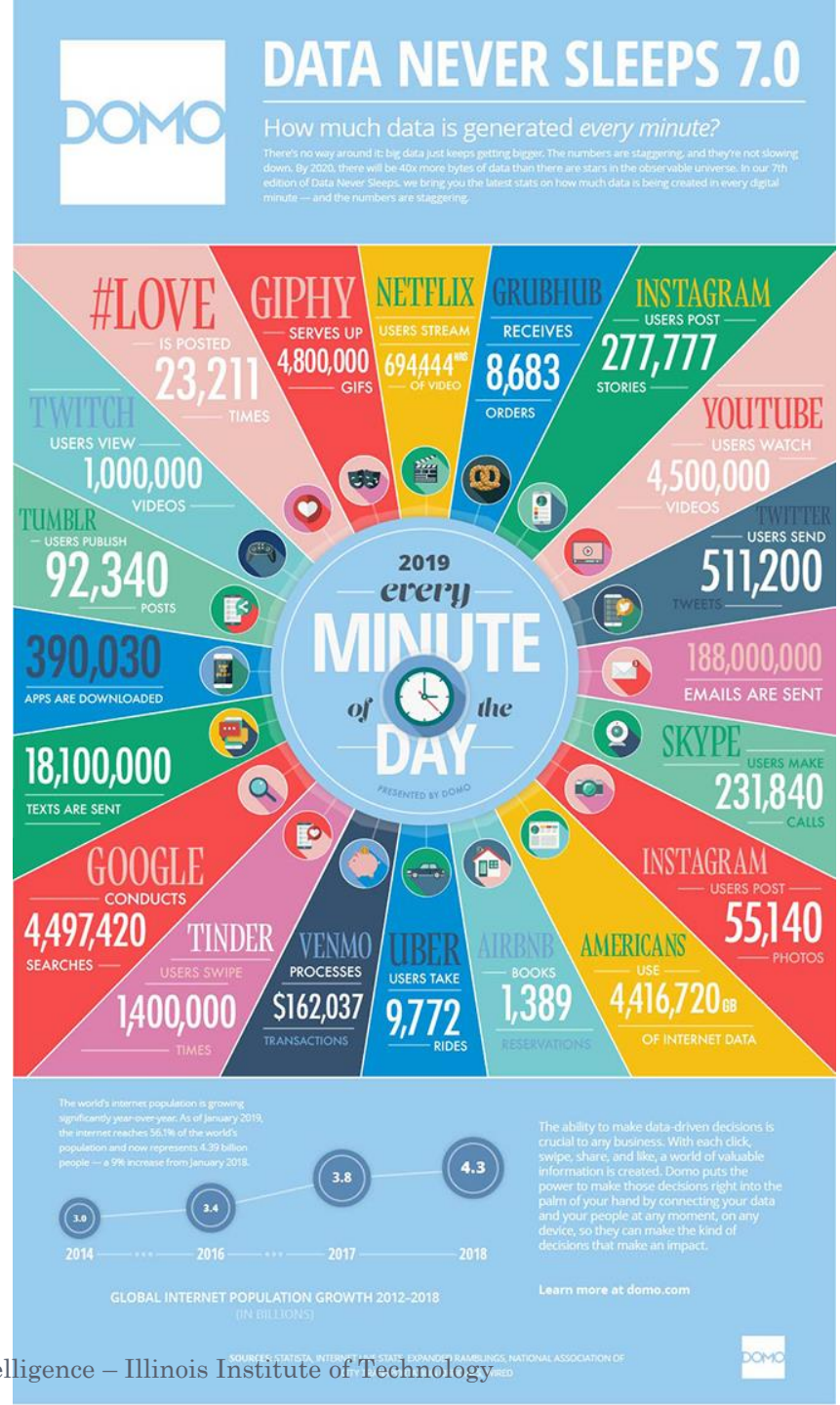
DOMO
DATA NEVER SLEEPS 7.0
How much data is generated every minute?
There's no way around it: big data just keeps getting bigger. The numbers are staggering, and they're not slowing down. By 2020, there will be 40x more bytes of data than there are stars in the observable universe. In our 7th edition 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.
#LOVE IS POSTED 23,211 TIMES
GIPHY SERVES UP 4,800,000 GIFS
NETFLIX USERS STREAM 694,444 HRS OF VIDEO
GRUBHUB RECEIVES 8,683 ORDERS
INSTAGRAM USERS POST 277,777 STORIES
TWITCH USERS VIEW 1,000,000 VIDEOS
YOUTUBE USERS WATCH 4,500,000 VIDEOS
TUMBLR USERS PUBLISH 92,340 POSTS
TWITTER USERS SEND 511,200 TWEETS
2019 every MINUTE of the DAY
PRESENTED BY DOMO
390,030 APPS ARE DOWNLOADED
188,000,000 EMAILS ARE SENT
18,100,000 TEXTS ARE SENT
SKYPE USERS MAKE 231,840 CALLS
GOOGLE CONDUCTS 4,497,420 SEARCHES
INSTAGRAM USERS POST 55,140 PHOTOS
TINDER USERS SWIPE 1,400,000 TIMES
VENMO PROCESSES $162,037 TRANSACTIONS
UBER USERS TAKE 9,772 RIDES
AIRBNB BOOKS 1,389 RESERVATIONS
AMERICANS USE 4,416,720 GB OF INTERNET DATA
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.
3.0
3.4
3.8
4.3
2014
2016
2017
2018
GLOBAL INTERNET POPULATION GROWTH 2012–2018
(IN BILLIONS)
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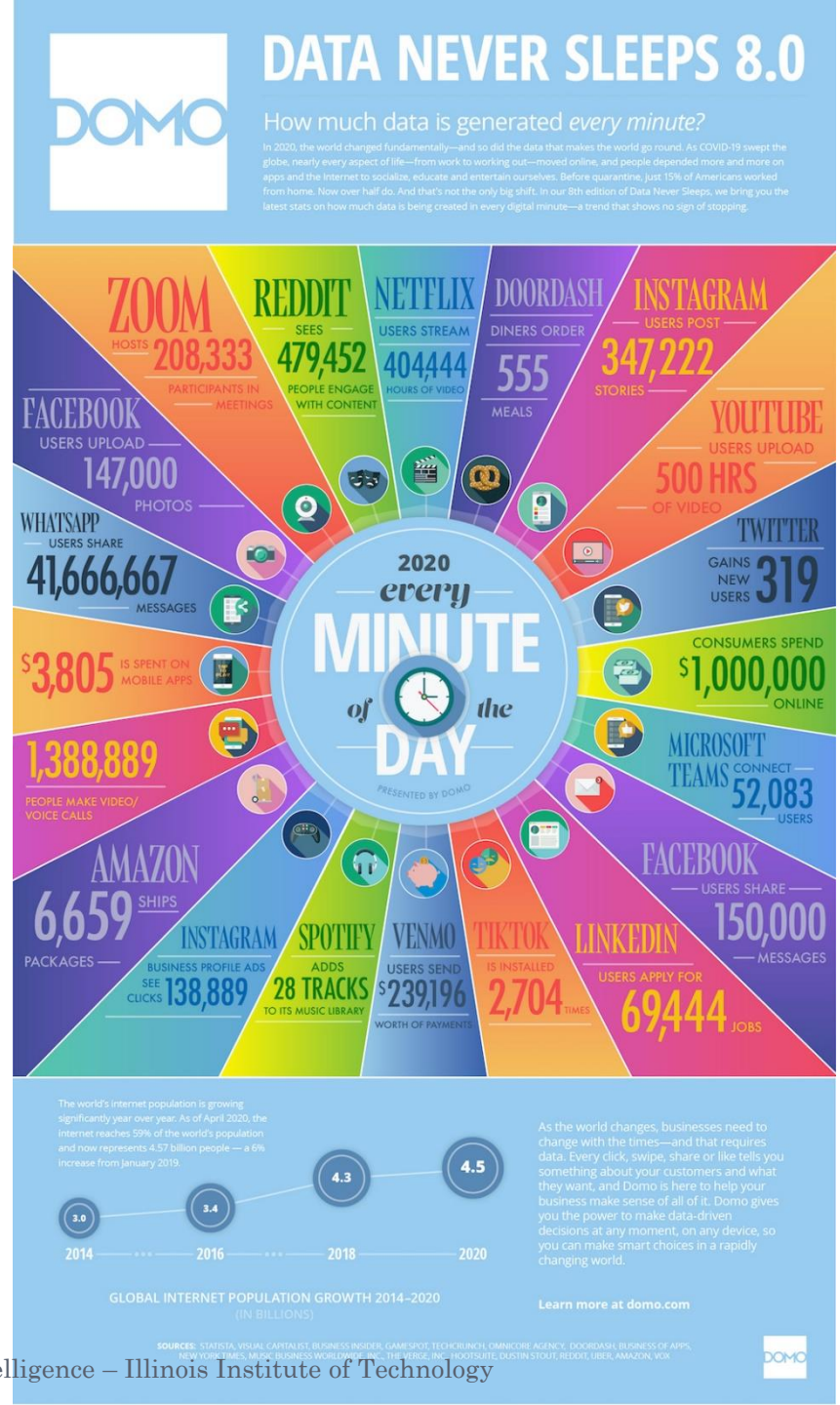
SOURCES: STATISTA, INTERNET LIVE STATS, EXPANDED RAMBLINGS, NATIONAL ASSOCIATION OF
DOMO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DATA NEVER SLEEPS 8.0
How much data is generated every minute?
In 2020, the world changed fundamentally—and so did the data that makes the world go round. As COVID-19 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.
ZOOM HOSTS 208,333 PARTICIPANTS IN MEETINGS
REDDIT SEES 479,452 PEOPLE ENGAGE WITH CONTENT
NETFLIX USERS STREAM 404,444 HOURS OF VIDEO
DOORDASH DINERS ORDER 555 MEALS
INSTAGRAM USERS POST 347,222 STORIES
FACEBOOK USERS UPLOAD 147,000 PHOTOS
YOUTUBE USERS UPLOAD 500 HRS OF VIDEO
WHATSAPP USERS SHARE 41,666,667 MESSAGES
TWITTER GAINS NEW USERS 319
2020 every MINUTE of the DAY
PRESENTED BY DOMO
$3,805 IS SPENT ON MOBILE APPS
CONSUMERS SPEND $1,000,000 ONLINE
1,388,889 PEOPLE MAKE VIDEO/VOICE CALLS
MICROSOFT TEAMS CONNECT 52,083 USERS
AMAZON 6,659 SHIPS PACKAGES
INSTAGRAM BUSINESS PROFILE ADS SEE CLICKS 138,889
SPOTIFY ADDS 28 TRACKS TO ITS MUSIC LIBRARY
VENMO USERS SEND $239,196 WORTH OF PAYMENTS
TIKTOK IS INSTALLED 2,704 TIMES
LINKEDIN USERS APPLY FOR 69,444 JOBS
FACEBOOK USERS SHARE 150,000 MESSAGES
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.
3.0
3.4
4.3
4.5
2014
2016
2018
2020
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
SOURCES: STATISTA, VISUAL CAPITALIST, BUSINESS INSIDER, GAMESPOT, TECHCRUNCH, OMNICORE AGENCY, DOORDASH, BUSINESS OF APPS, NEW YORK TIMES, MUSIC BUSINESS WORLDWIDE, ETC., THEVERGE, INC., HOOTSUITE, DUSTIN STOUT, REDDIT, UBER, AMAZON, VOX
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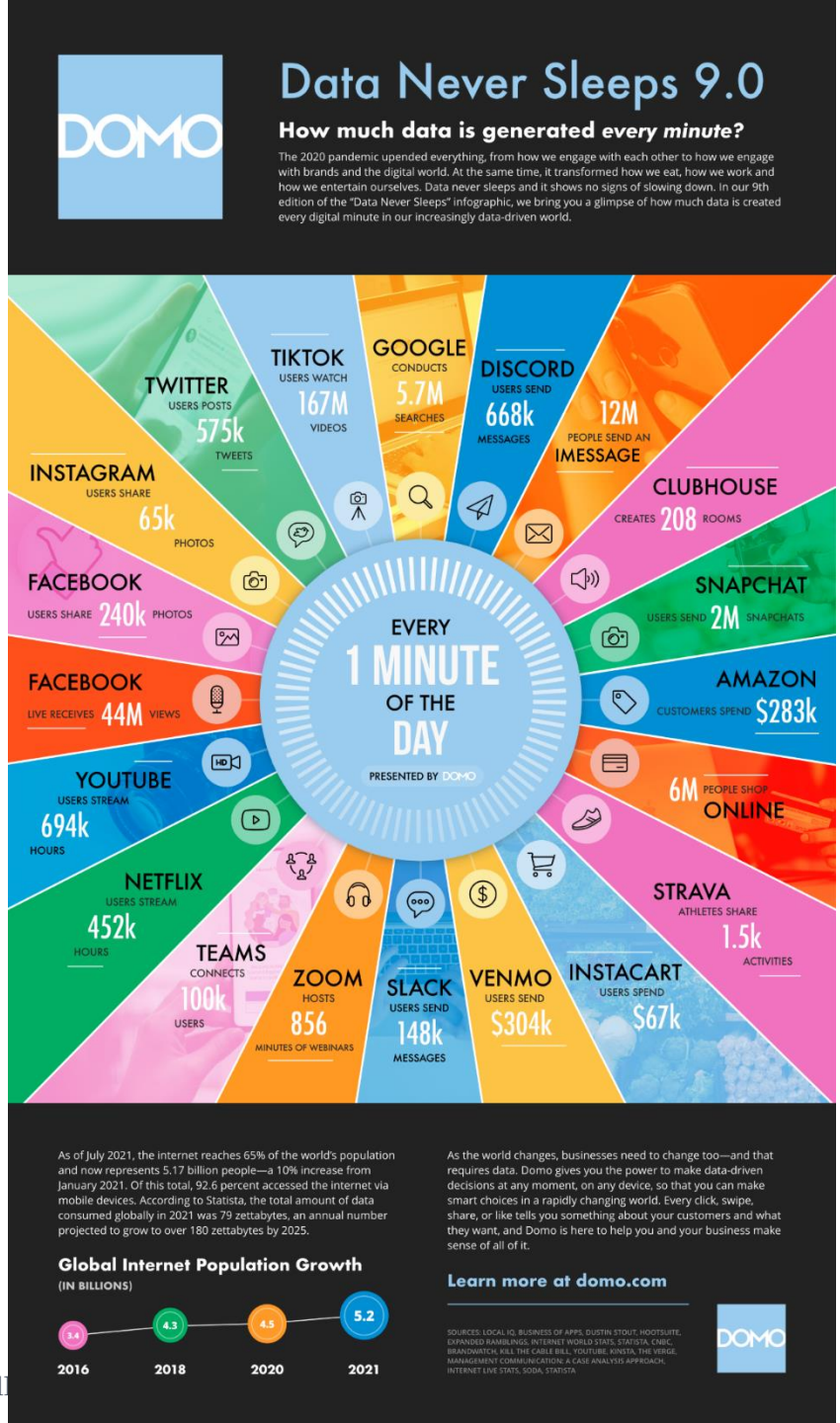
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Data Never Sleeps 9.0
How much data is generated every minute?
The 2020 pandemic upended everything, from how we engage with each other to how we engage with brands and the digital world. At the same time, it transformed how we eat, how we work and 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.
EVERY 1 MINUTE OF THE DAY
PRESENTED BY DOMO
TWITTER USERS POSTS 575k TWEETS
TIKTOK USERS WATCH 167M VIDEOS
GOOGLE CONDUCTS 5.7M SEARCHES
DISCORD USERS SEND 668k MESSAGES
12M PEOPLE SEND AN IMESSAGE
CLUBHOUSE CREATES 208 ROOMS
SNAPCHAT USERS SEND 2M SNAPCHATS
AMAZON CUSTOMERS SPEND $283k
6M PEOPLE SHOP ONLINE
STRAVA ATHLETES SHARE 1.5k ACTIVITIES
INSTACART USERS SPEND $67k
VENMO USERS SEND $304k
SLACK USERS SEND 148k MESSAGES
ZOOM HOSTS 856 MINUTES OF WEBINARS
TEAMS CONNECTS 100k USERS
NETFLIX USERS STREAM 452k HOURS
YOUTUBE USERS STREAM 694k HOURS
FACEBOOK LIVE RECEIVES 44M VIEWS
FACEBOOK USERS SHARE 240k PHOTOS
INSTAGRAM USERS SHARE 65k PHOTOS
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)
3.4
4.3
4.5
5.2
2016
2018
2020
2021
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SOURCES: LOCAL IQ, BUSINESS OF APPS, DUSTIN STOUT, HOOTSUITE, EXPANDED RAMBLINGS, INTERNET WORLD STATS, STATISTA, CNBC, BRANDWATCH, KILL THE CABLE BILL, YOUTUBE, KINSTA, THE VERGE, MANAGEMENT COMMUNICATION: A CASE ANALYSIS APPROACH, INTERNET LIVE STATS, SODA, STATISTA
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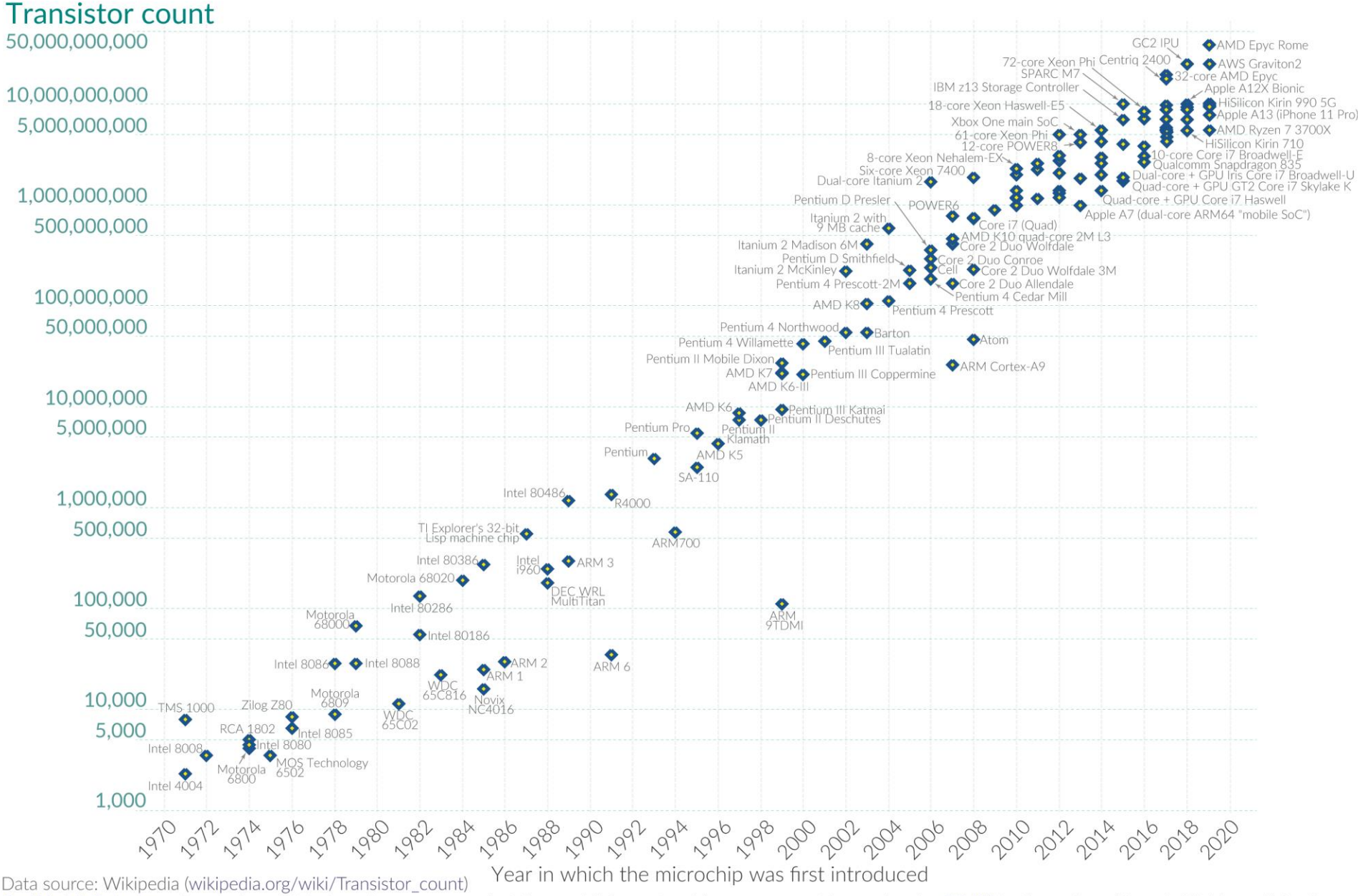
Moore's Law: The number of transistors on microchips doubles every two years

Our World in Data

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.



Data source: Wikipedia (wikipedia.org/wiki/Transistor_count)

OurWorldinData.org – Research and data to make progress against the world's largest problems.

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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/ccc/visioning/visioning-activities/2018-activities/artificial-intelligence-roadmap/

CS 581

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