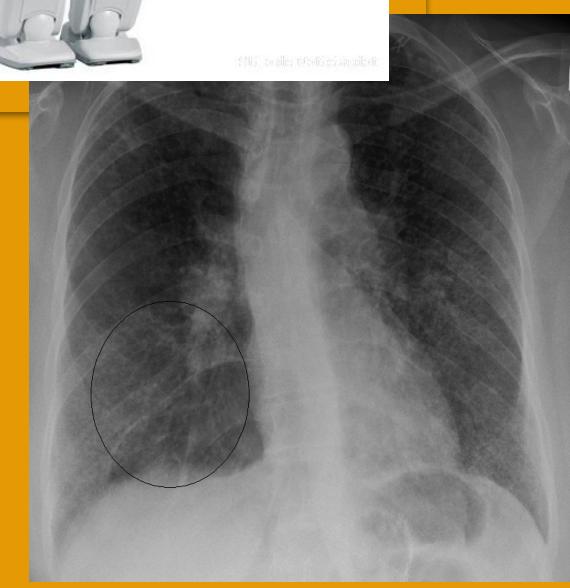
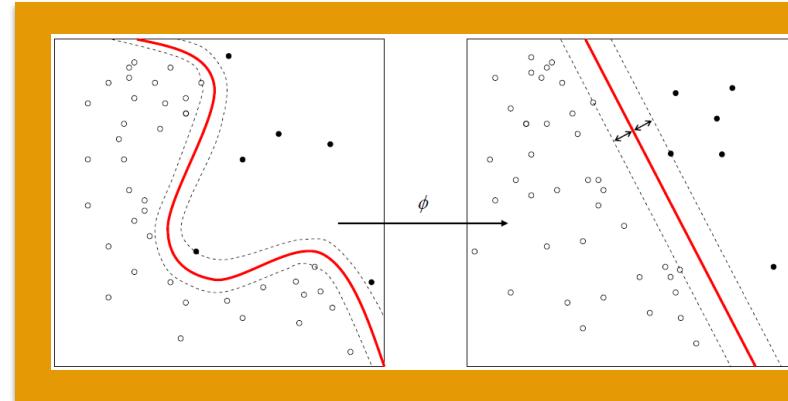


Deep Learning

Dr. Guha Jayachandran
January 24, 2018

Deep Learning is Amazing



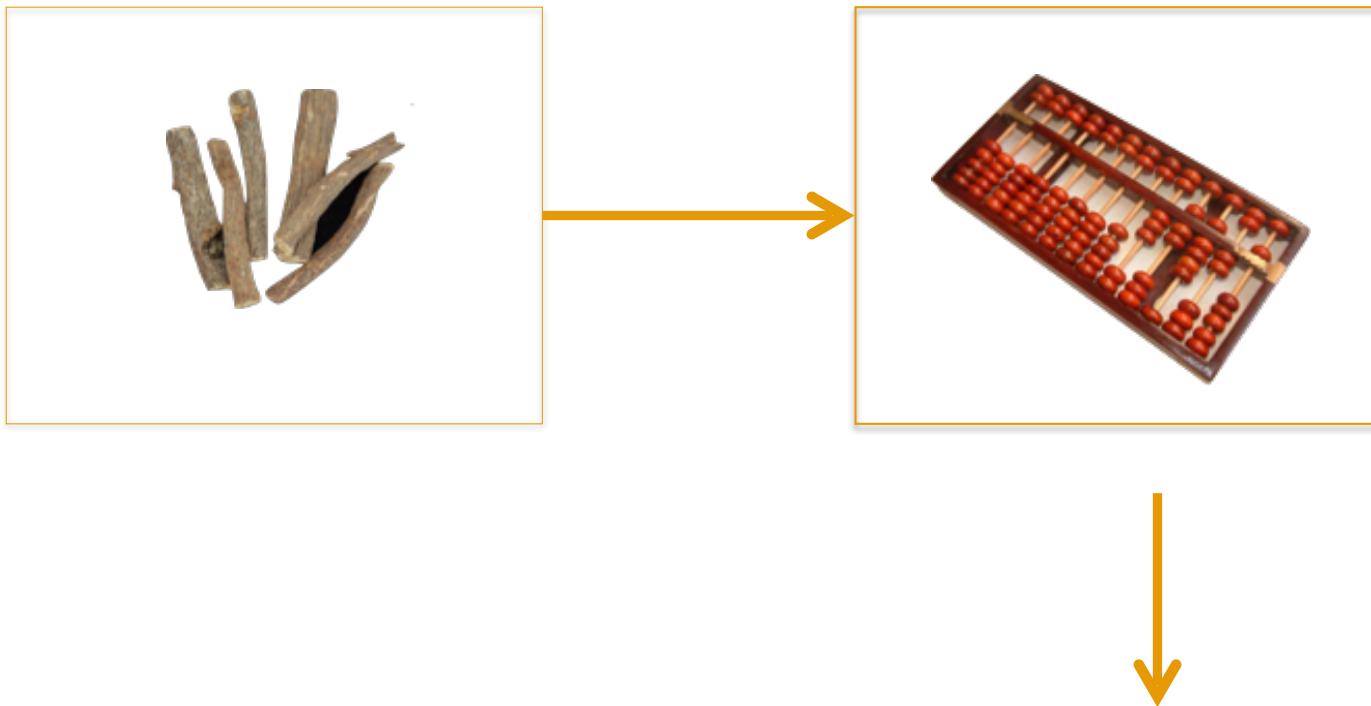
“The computer is incredibly fast, accurate, and stupid. Man is unbelievably slow, inaccurate, and brilliant. The marriage of the two is a challenge and opportunity beyond imagination.”

–Stuart Walesh

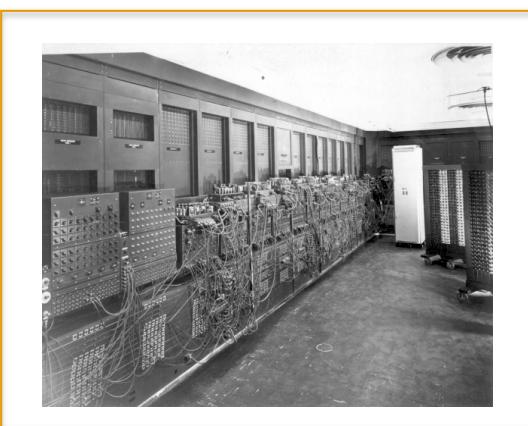
**He said that before Deep Learning came along!
Now computers can perform many tasks that only humans could before.
But remember it's still computation.**

Historical Context

Computation is Old



Explosion of Progress



Moore's Law

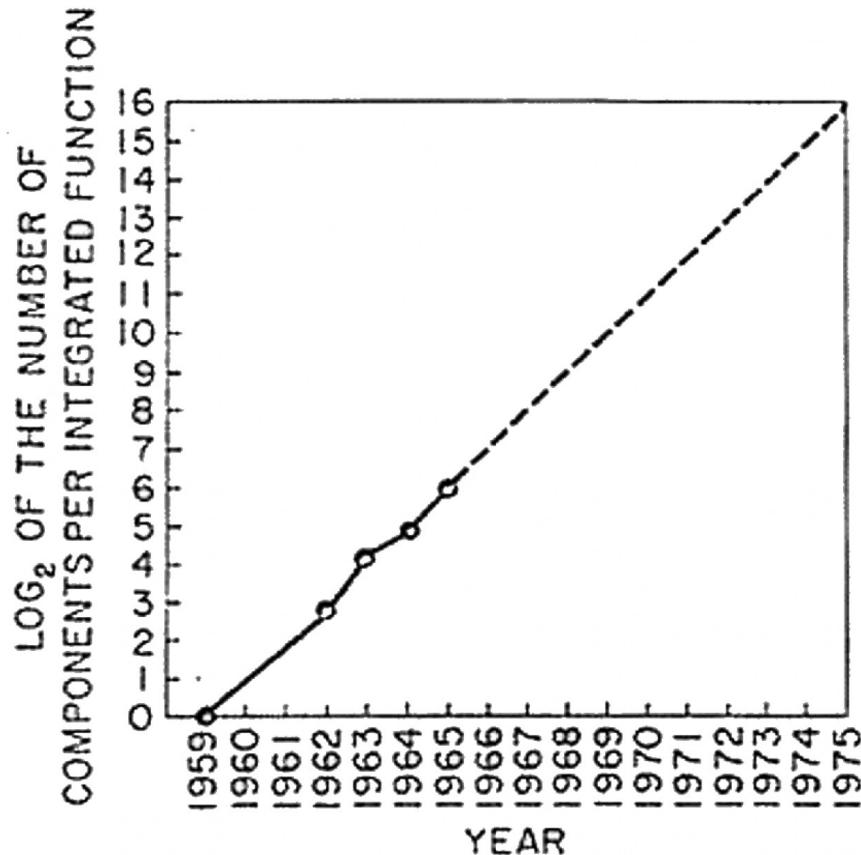
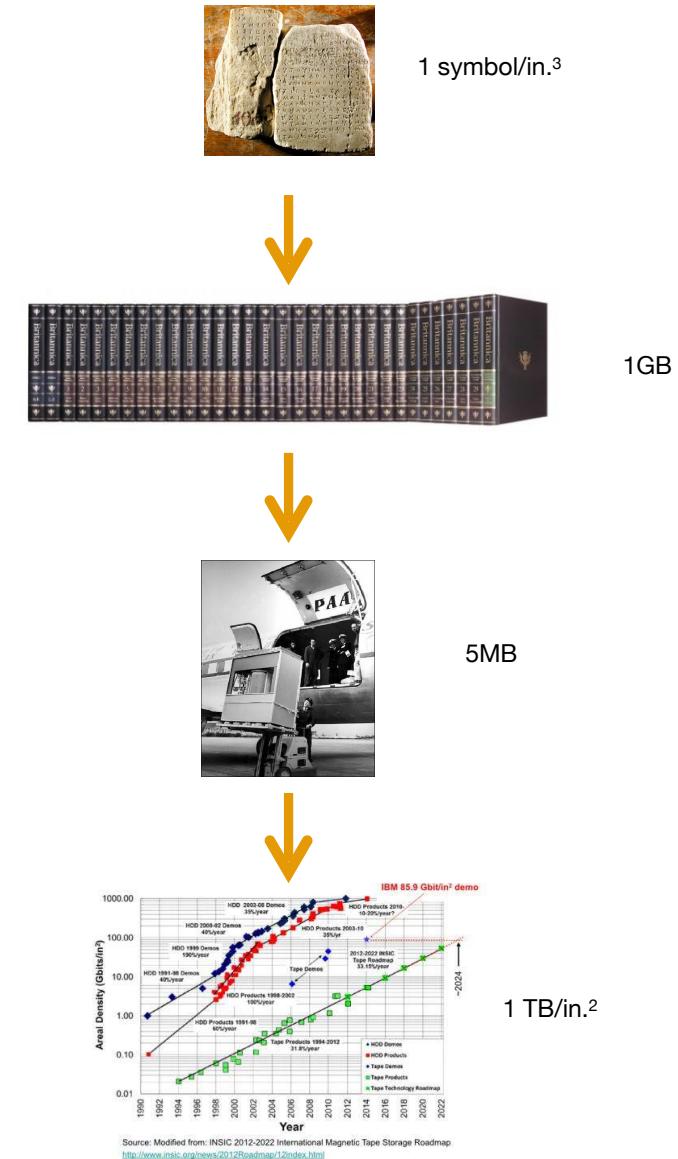


Fig. 2 Number of components per integrated function for minimum cost per component extrapolated vs time.

1965 Electronics magazine
From: Fairchild internal document



Enablers of Today's Revolution

Computational power

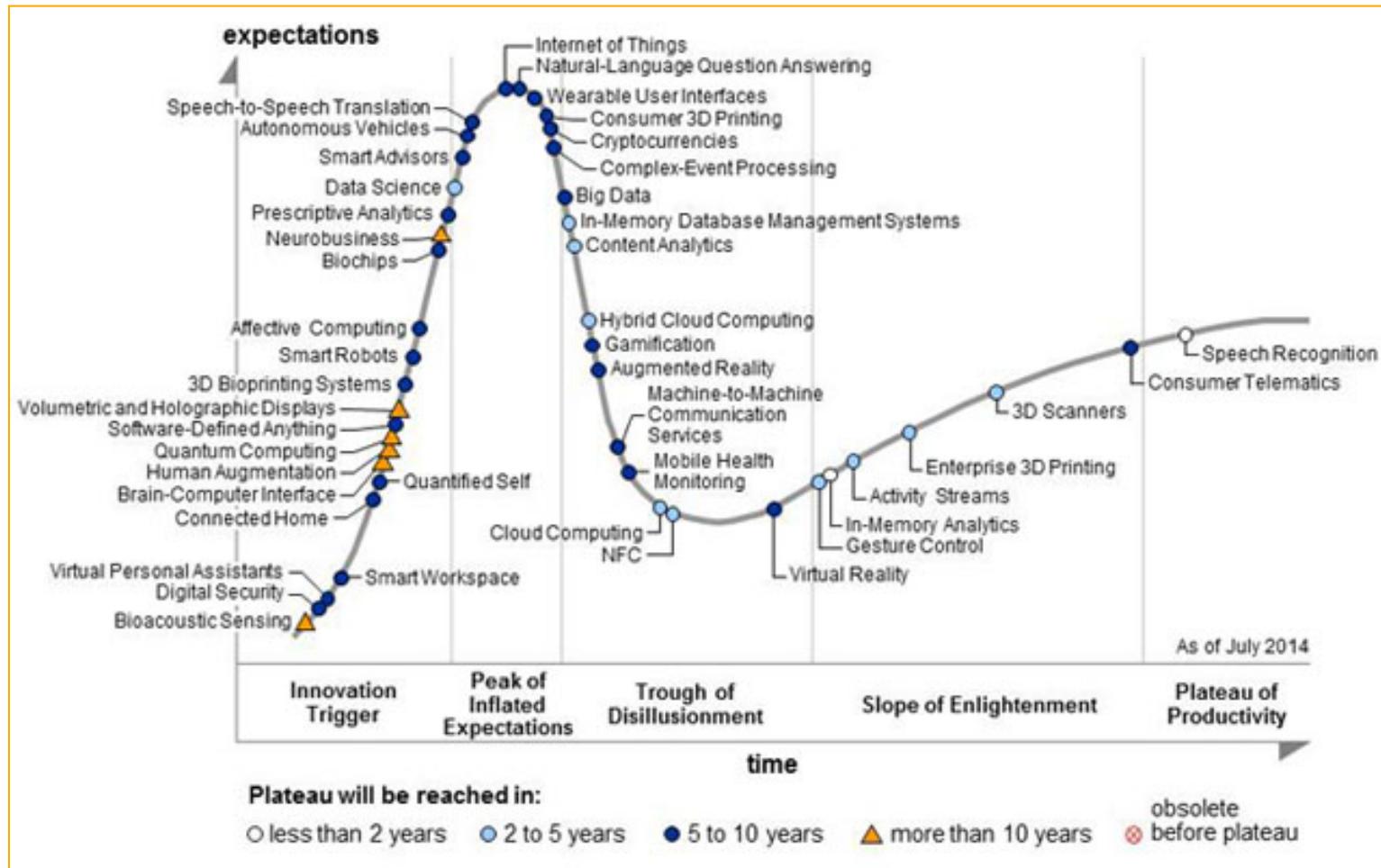


Data

Models

Hype Isn't New

2014 Gartner Hype Cycle



"A.I. Winters"
followed previous
waves of excitement

Field Context

Many Terms

Artificial intelligence

The science and engineering of making intelligent machines

Computer vision

Processing and understanding images

Big Data

Collection and analysis of very large datasets

Data science

Extraction of insight from data

Problems in A.I.

Reasoning

Knowledge Representation

Planning

Natural Language Processing

General
Intelligence

Learning

Manipulating Objects

Computer Vision

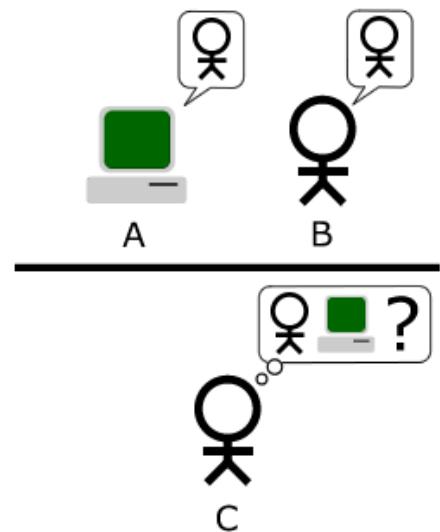
Tests



vs.

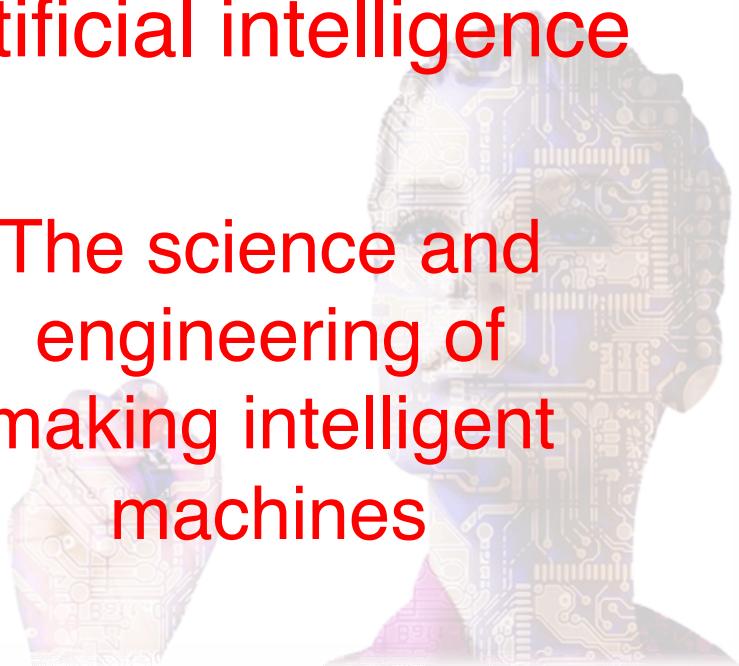


Turing Test



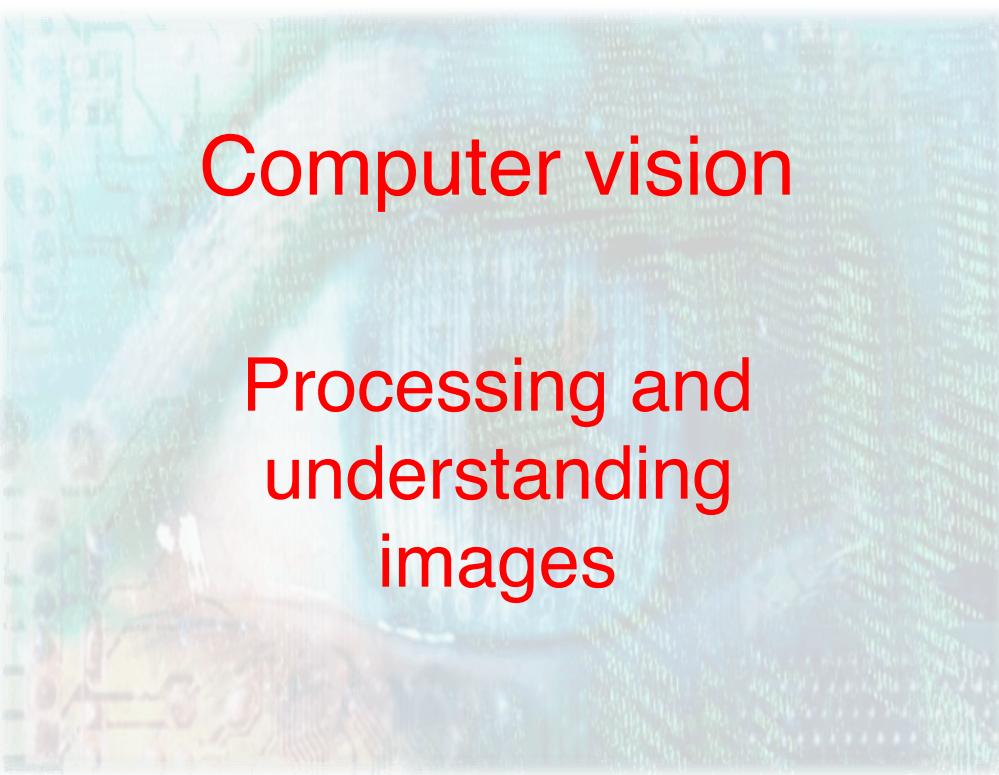
Artificial intelligence

The science and engineering of making intelligent machines



Computer vision

Processing and understanding images



Big Data

Collection and analysis of very large datasets

Data science

Extraction of insight from data





“It is a capital mistake to theorize before one has data.”

-Arthur Conan Doyle



CALENDAR OF MEANINGFUL DATES

EACH DATE'S SIZE REPRESENTS HOW OFTEN IT IS REFERRED TO BY NAME
(E.G. "OCTOBER 17TH") IN ENGLISH-LANGUAGE BOOKS SINCE 2000
(SOURCE: GOOGLE NGRAMS CORPUS)

JANUARY

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

1	2	3	4
5	6	7	8
9	10	11	12
12	13	14	15
16	17	18	19
19	20	21	22
23	24	25	26
26	27	28	29

MARCH

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	30
31		

APRIL

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
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1	2	3	4	5
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11	12	13	14	15
16	17	18	19	20
20	21	22	23	24
25	26	27	28	29
30	31			

1	2					
3	4	5	6	7	8	
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

JULY

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

1	2	3	4
5	6	7	8
9	10	11	12
12	13	14	15
16	17	18	19
19	20	21	22
23	24	25	26
26	27	28	29
30	31		

SEPTEMBER

1						
23	24	25	26	27	28	29
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

OCTOBER

1	2	3	4	5	6	
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

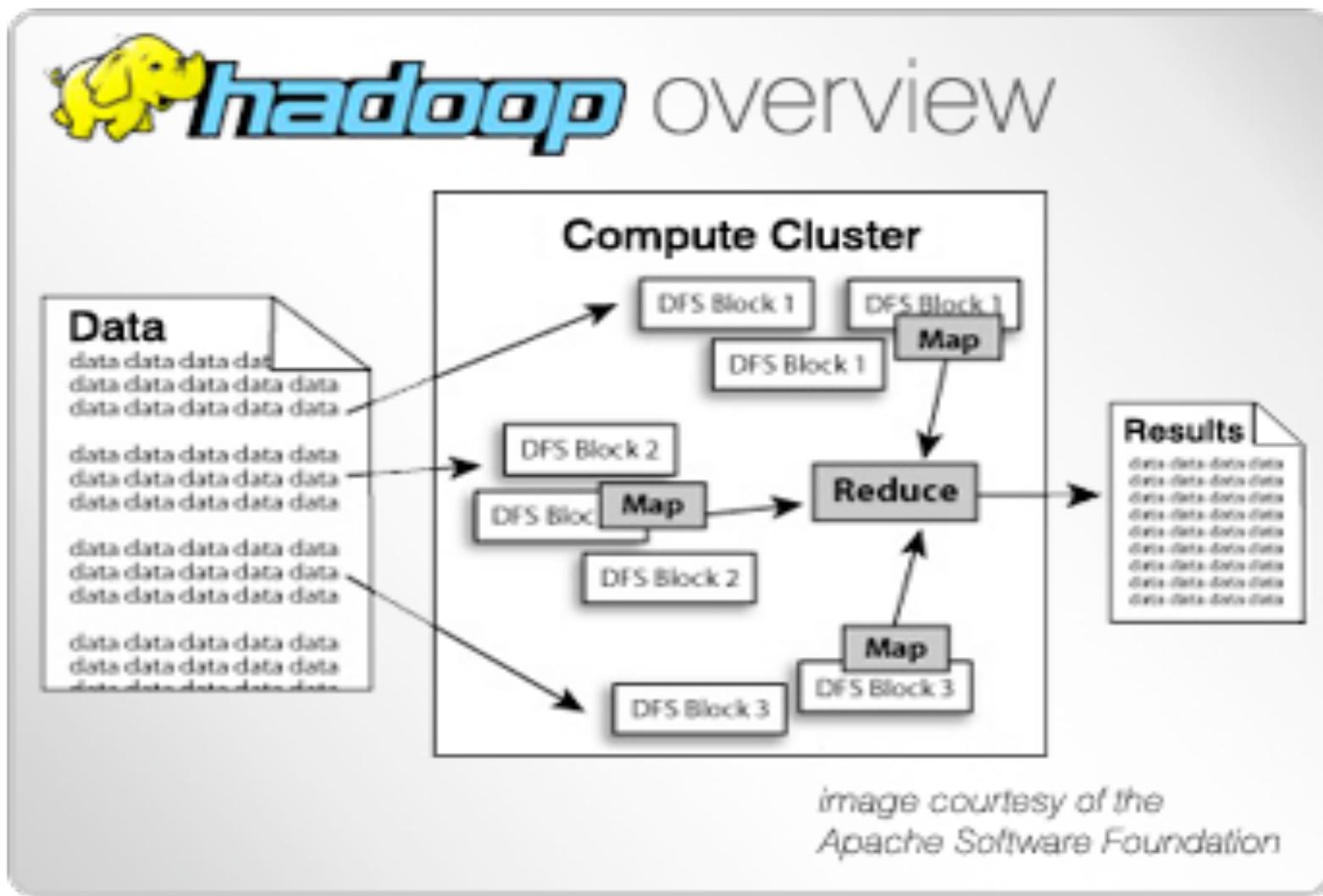
1	2	3				
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

DECEMBER

1						
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

How would
you do this
analysis?

Map/Reduce



Exploit Parallelism



Exploit Parallelism



LET'S SOLVE THIS PROBLEM BY
USING THE BIG DATA NONE
OF US HAVE THE SLIGHTEST
IDEA WHAT TO DO WITH



© marketoonist.com

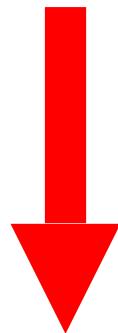
<https://marketoonist.com/2014/01/big-data.html>

Data, data everywhere...

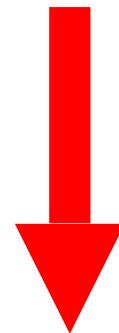


12:00AM

All of
human
history
until 2004



~5 Exabytes



11:59PM

Today

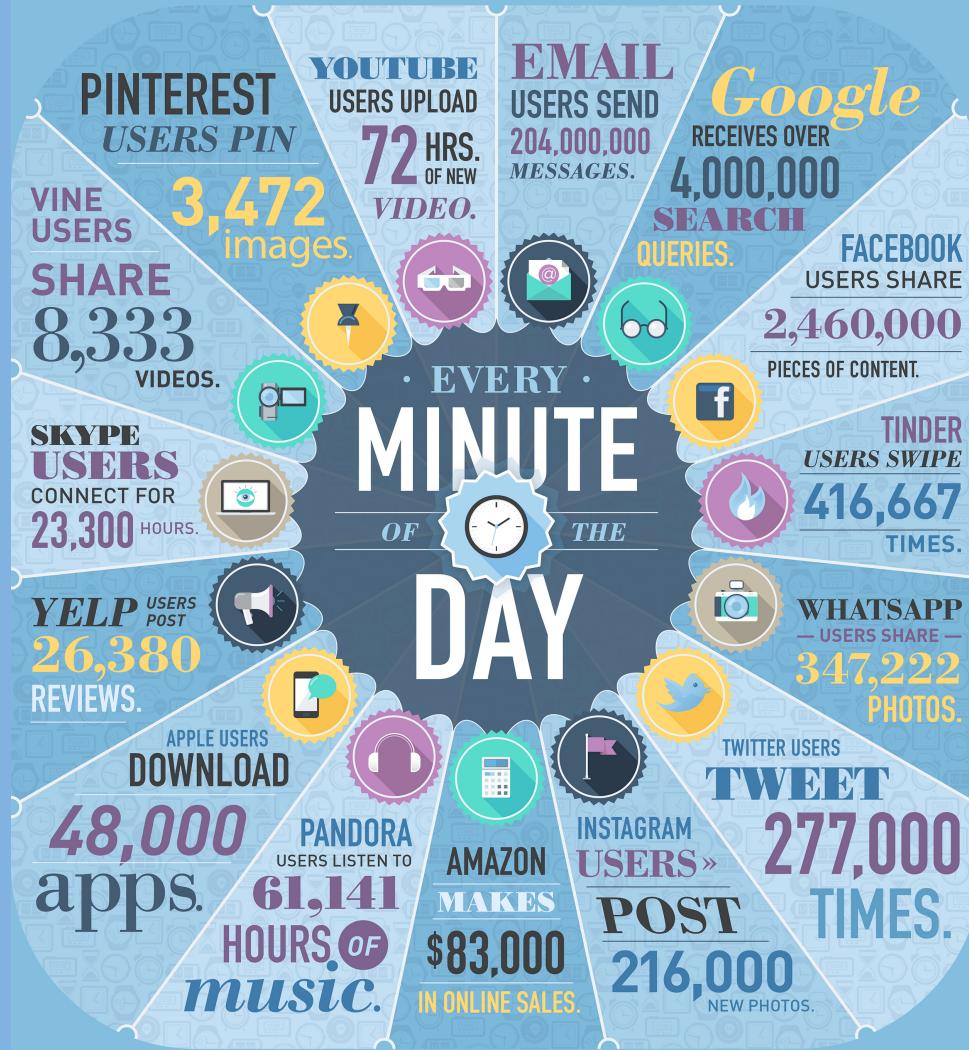
~5 Exabytes



DATA NEVER SLEEPS 2.0

How Much Data is Generated Every Minute?

Data is being created every minute of every day without us even noticing it. Given how much information is being created in these days, it's no surprise to talk about big data only in terms of size. Big data describes the massive avalanche of digital activity pulsating through cables and airwaves, but it also describes all the things we were never able to measure before. With every status we share, every article we read or every photo we upload, we are creating a digital trail that tells a story. Below, we explore how much data is generated in one minute.



THE GLOBAL INTERNET POPULATION GREW 14.3% FROM 2011-2013 AND NOW REPRESENTS

2.4 BILLION PEOPLE.

With each click, share and like, the world's data pool is expanding faster than we can comprehend. Businesses today are paying attention to scores of data sources to make crucial decisions about the future. The team at Domo can help your business make sense of this endless stream of data by providing executives with all their critical information in one intuitive platform. Domo delivers the insights you need to transform the way you run your business. Learn more at www.domo.com.

SOURCES:

BITS.BLOGS.NYTIMES.COM, INTEL.COM, APPLE.COM, TIME.COM, DAILYMAIL.CO.UK, SKYPE.COM, STATISTICBRAIN.COM



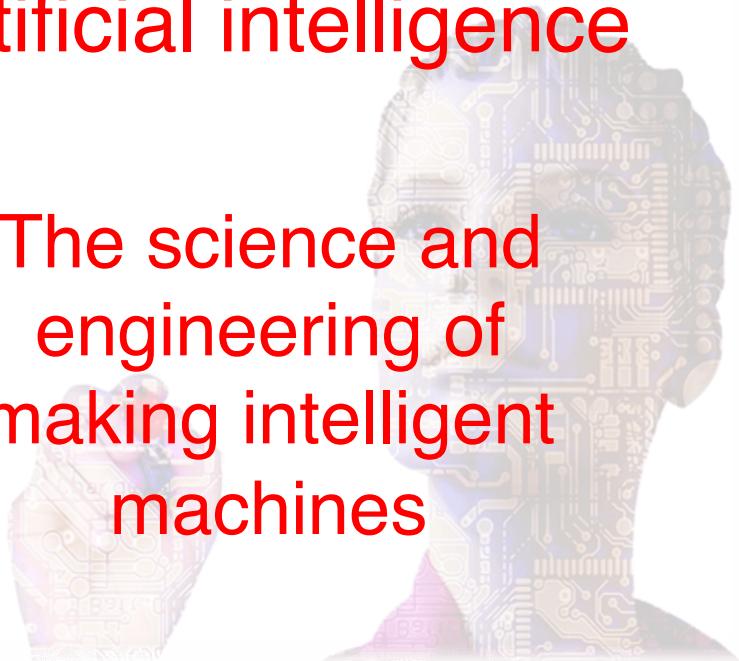
How Big is “Big?”

Data so large that
“traditional” data processing
techniques are insufficient.

Virtually the entirety of data
available for a given
“substantial” domain.

Artificial intelligence

The science and engineering of making intelligent machines



Big Data

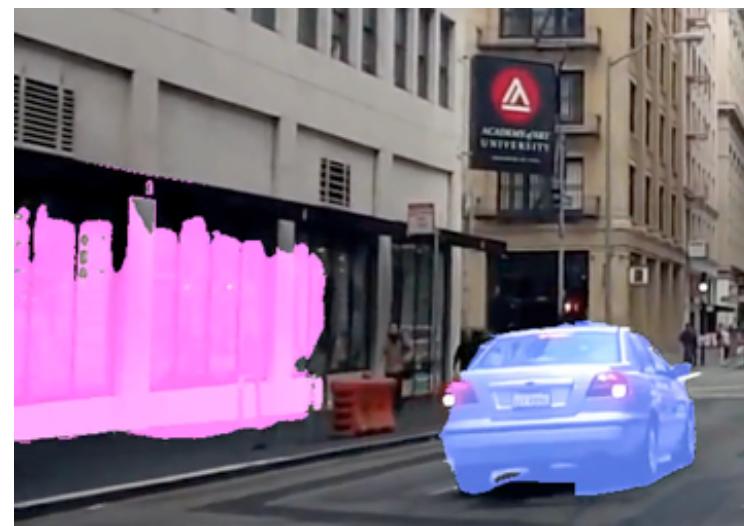
Collection and analysis of very large datasets

Computer vision

Processing and understanding images

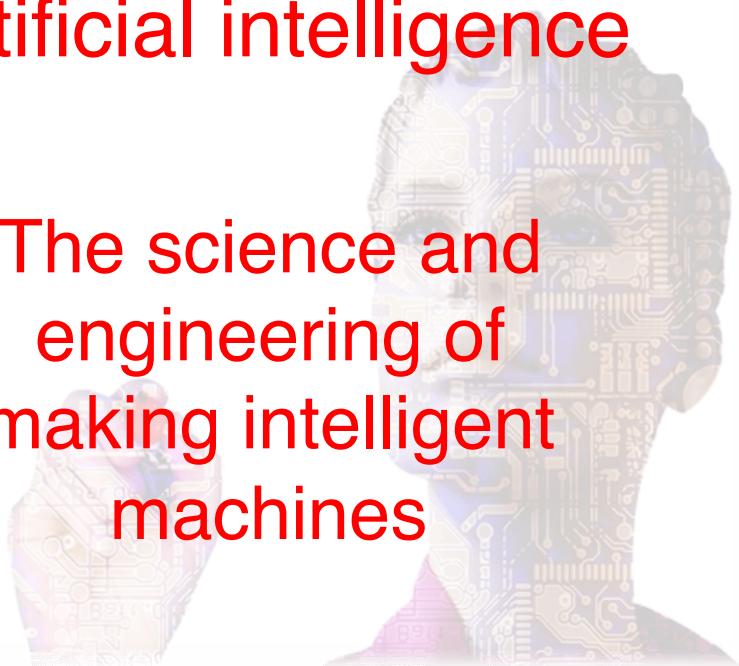
Data science

Extraction of insight from data



Artificial intelligence

The science and engineering of making intelligent machines



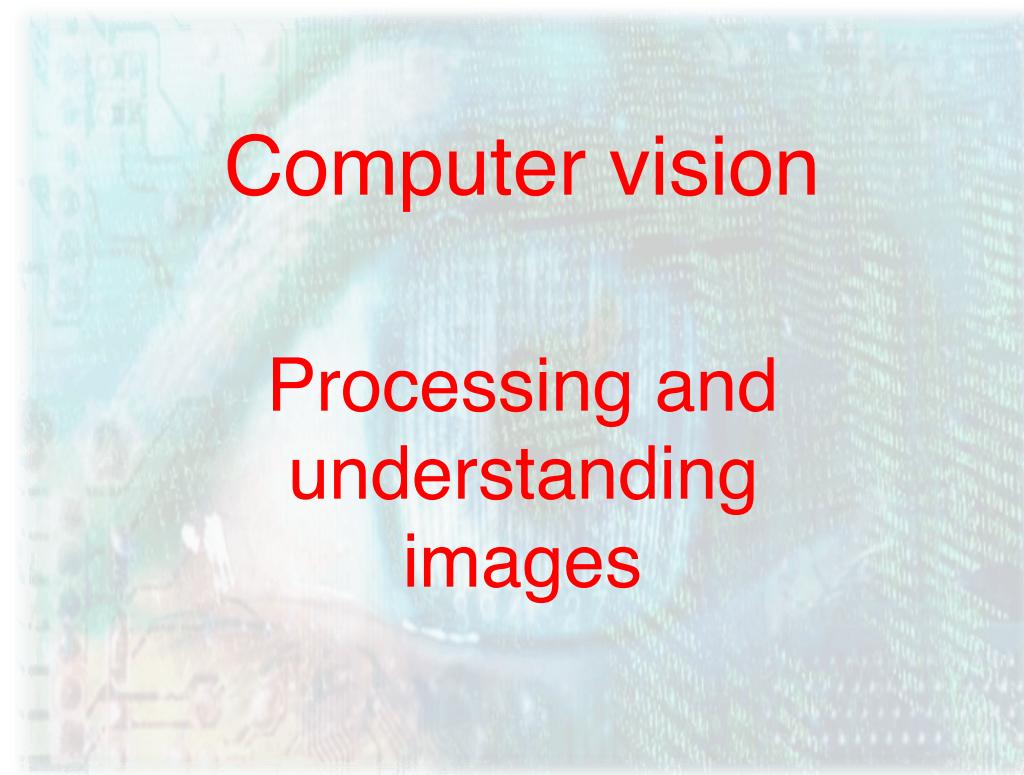
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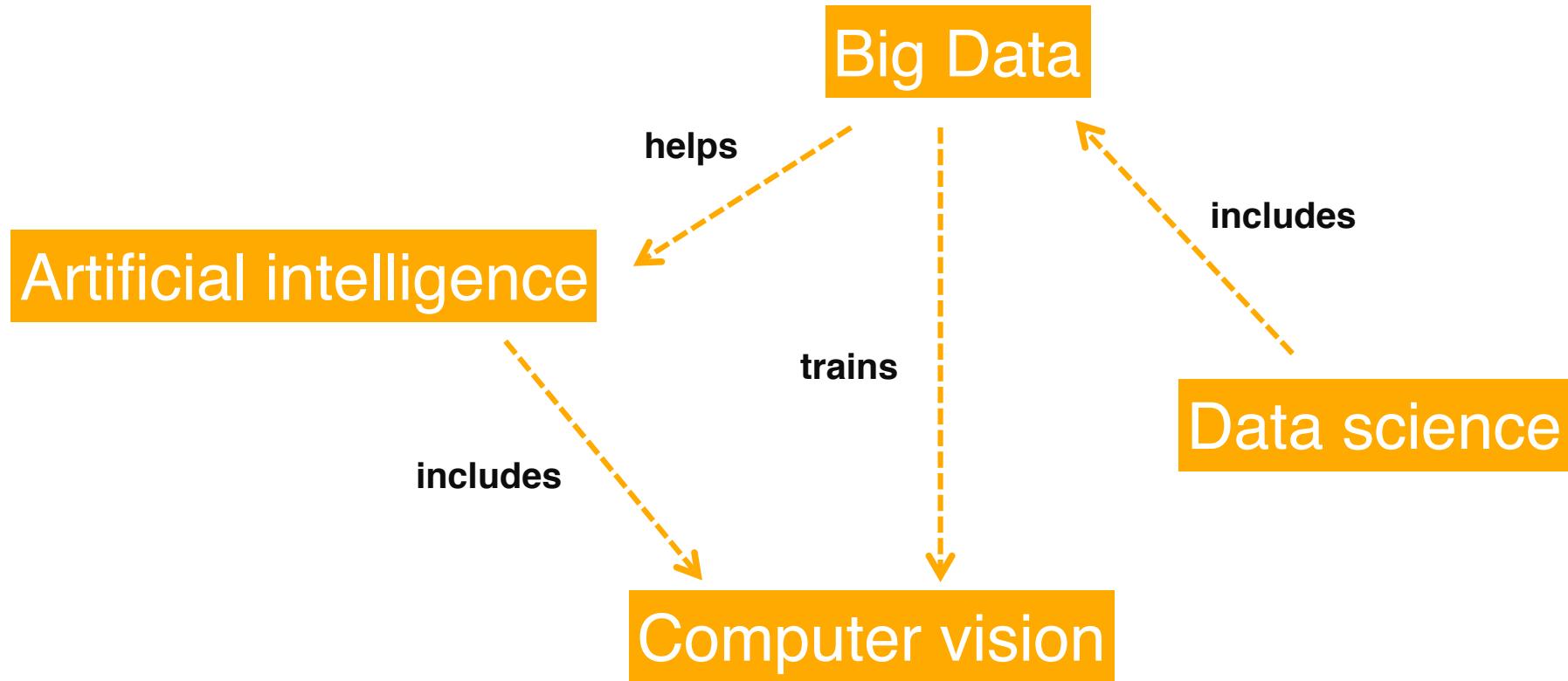


“At the heart of science is an essential balance between two seemingly contradictory attitudes—an openness to new ideas, no matter how bizarre or counterintuitive, and the most ruthlessly skeptical scrutiny of all ideas, old and new. This is how deep truths are winnowed from deep nonsense.”

–Carl Sagan



Synthesis



What should you care about?

Applications in All Fields

Biology

Medicine

Retail

Security

Agriculture

Physics

Simulations

Logistics

Social networks

Media

Transportation

Deep Learning

Deep Learning

- Formally: Machine learning methods based on learning data representations
- Informally: Deep neural networks (including recurrent neural networks, convolutional networks, and more)

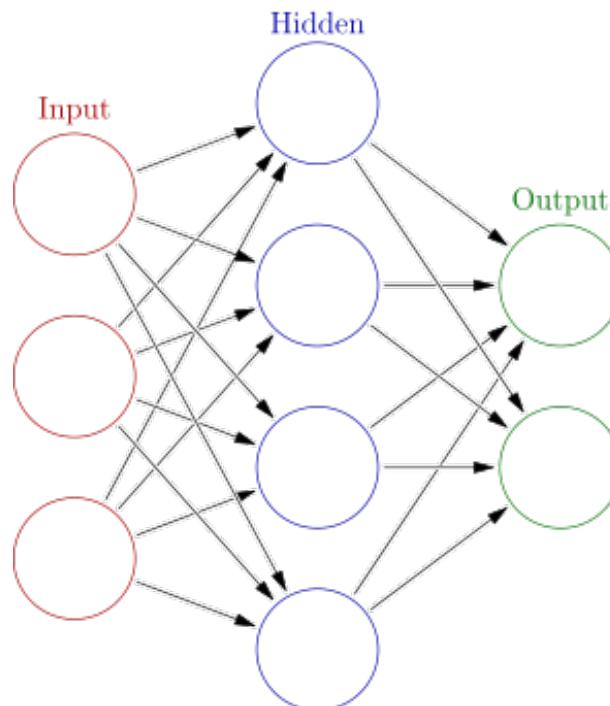
Deep Neural Network

- *Neural network* with several layers between the input and output layers
- The network is deep!

Neural Network

- “Artificial” neural network if you want to be picky

- We’ll review next class



Sample Applications

- Image recognition
- Machine translation
- Speech recognition
- Recommendations
- Bioinformatics
- Applications to almost any field!